

TM 9-4935-260-14

Put in HIPAR.

TECHNICAL MANUAL

TELONIC

**Operator, Organizational, DS, and GS
Maintenance Manual.**

SWEEP GENERATOR 8031111

(Telonic SM-2000X11-1)

**(IMPROVED NIKE-HERCULES AND NIKE-HERCULES
ATBM AIR DEFENSE GUIDED MISSILE SYSTEMS)**

HEADQUARTERS, DEPARTMENT OF THE ARMY

AUGUST 1977

765

X AMP

TUNED MATCH
NETWORK

CH1

CH2

MODE SWITCH
CHOP

LOGIC DISPLAY

X AMP

TO

"

"

"

2000

HORIZ.

RF 1

MARKER ADDER
OUT

IF DETECTOR

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CHAPTER 1

INTRODUCTION

1-1. Scope

a. Information in this manual is published for the guidance of personnel responsible for the operation and maintenance of the sweep generator (Telonic SM-2000X11-1) and its associated equipment. This manual contains information on the description, operation, theory, and maintenance of the sweep generator, the S-100B sweep oscillator plug-in, and the three MHz -X1 harmonic marker plug-ins.

b. Instructions in this manual are intended for maintenance specialists, trained in electronic maintenance practices, but not necessarily familiar with the equipment covered in this manual.

c. The Telonic sweep generator is authorized at HIPAR and in the special test equipment group in the support shop. With the application of MWO 9-4900-250-50-29 to Shop 2, however, the requirement for the sweep generator is deleted from the shop.

1-2. Related Publications

a. This is one of a series of technical manuals on the NIKE Air Defense Guided Missile Systems. The complete library of publications covering the missile systems is listed in TM 9-1425-250-L.

b. A list of repair parts authorized for direct support (DS) and general support (GS) is published

in TM 9-4940-253-14P-1. The sweep generator is authorized by SC 4935-92-CL-003.

1-3. Forms, Records, and Reports

Refer to TM 38-750 for instructions on the use and completion of all forms required for operating and maintaining the equipment.

1-4. Difference Between Models

The originally issued sweep generator was equipped with the S-100 sweep oscillator. The S-100 is now obsolete and must be replaced by the S-100B which is covered in this manual.

1-5. MWO Effectivity

a. There are no outstanding modification work orders (MWO's) affecting the sweep generator assembly.

b. For a description of all NIKE modifications and a configuration history of the system, refer to TB 9-1425-250-15/1.

1-6. General Maintenance

Refer to TM 9-1400-250-15/3 for general maintenance information, including cleaning, painting, lubricating, and schematic and wiring diagram symbols.

CHAPTER 2

DESCRIPTION

Section I. INTRODUCTION

2-1. General Description

a. The sweep generator, commonly called the SM-2000, consists of five separate assemblies. They are the sweep generator mainframe, the sweep oscillator plug-in, and three harmonic marker plug-ins.

b. The sweep generator is used primarily for checking bandwidth, frequency, and gain of amplifiers.

(1) Sweep generator mainframe, SM-2000X11-1 (8031112).

(2) Sweep oscillator plug-in, S-100B (8031406).

(3) Harmonic marker plug-in, CDH-0.1 MHz X1 (8031115).

(4) Harmonic marker plug-in, CDH-1.0 MHz X1 (8031116).

(5) Harmonic marker plug-in, CDH-10.1 MHz X1 (8031114).

2-2. Functional Description

a. Basically, the sweep generator mainframe is a variable power supply with sweep and modulator circuits for the sweep oscillator plug-in.

b. The sweep oscillator plug-in is the RF generator. The frequency of the oscillator is controlled by voltages received from the sweep generator mainframe.

c. Three harmonic marker plug-ins supply marker pips for indicating devices such as oscilloscopes and rectangular coordinate plotters. There are connections for eight markers, but only three are used.

CAUTION

Never insert a plug-in unit while the power is on. Transient voltages may result in diode damage.

b. Marker plug-ins must be inserted into the mainframe and all coaxial cables must be connected as shown in figures 3-1 and 4-1. Any other connection configuration will not be compatible with the text or schematics in this manual.

2-3. NIKE Configuration

a. The sweep generator configuration authorized for NIKE and covered in this manual consists of the following assemblies:

2-4. Electrical Data

Electrical data for the five assemblies of the sweep generator is listed in table 2-1.

Table 2-1. Sweep Generator Electrical Data

SM-2000X11-1 sweep generator	
Output flatness	Typically ± 0.25 db
Source impedance	75 ohms
RF1 attenuation	0-60 db in 1-db steps.
RF vernier level control	Typical accuracy to 900 MHz is $\pm 10\%$ or ± 0.7 db, whichever is greater. 0-6 db of range.
Modes of operation:	
SWEEP	Determined by SWEEP RATE switch 0.01 to 100 Hz.
CW	The RF output is a CW signal not swept.
MOD CW	The CW output is modulated with 1 kHz.
Zero reference line	Provided in sweep and modulated sweep modes by blanking of the oscillator during return sweep.

Table 2-1. Sweep Generator Electrical Data—Continued

SWEEP RATE	
Variable	0.01 to 100 Hz.
LINE	50 to 60 Hz.
MAN	Automatic drive is switched off, and the activated CW mode is controlled manually.
EXT	Rear panel connector J401 is provided for driving with an external signal.
Sweep-to-retrace ratio	
Variable sweep rate	1:1 or 10:1
Line sweep rate	1:1 only
Horizontal output	Approximately 15 volt P/P. Approximately 0 vdc average. Triangular or sawtooth.
Power	115 or 230 vac, 50 — 60 Hz, 200 watts.
S-100B plug-in sweep oscillator	
Sweep oscillator	
Center frequency range	0 to 250 MHz.
Sweep frequency range	0 to 250 MHz.
Sweep width	200 kHz to 70 MHz.
Output voltage	0.5 volts rms.
Amplitude level variation	±0.5 db maximum.
Linearity	1.5:1 at full sweep width.
Variable marker	
Frequency range (LOW band)	0 to 55 MHz ±300 kHz.
Frequency range (HI band)	50 to 125 MHz ±0.3%.
Harmonic band	125 to 250 MHz ±0.3%.
Calibration marks on dial	1 MHz.
MHz X-1 Harmonic markers	
Marker system	
Birdy-by-pass marker system	The output of the three harmonic markers (0.1 MHz, 1.0 MHz, 10.0 MHz) is mixed with a signal from the sweep oscillator to produce "beats" or "birdies." Amplitude and shape of each marker are adjustable over a wide range.

Section II. CONTROLS, INDICATORS, AND CONNECTORS

2-5. Front Panel

a. An illustration of the sweep generator front panel is provided in figure 2-1.

b. Descriptions of front panel controls, indicators, and connectors and their functions are described in table 2-2.

2-6. Rear Panel

Descriptions of rear panel indicators and connectors and their functions are described in table 2-3.

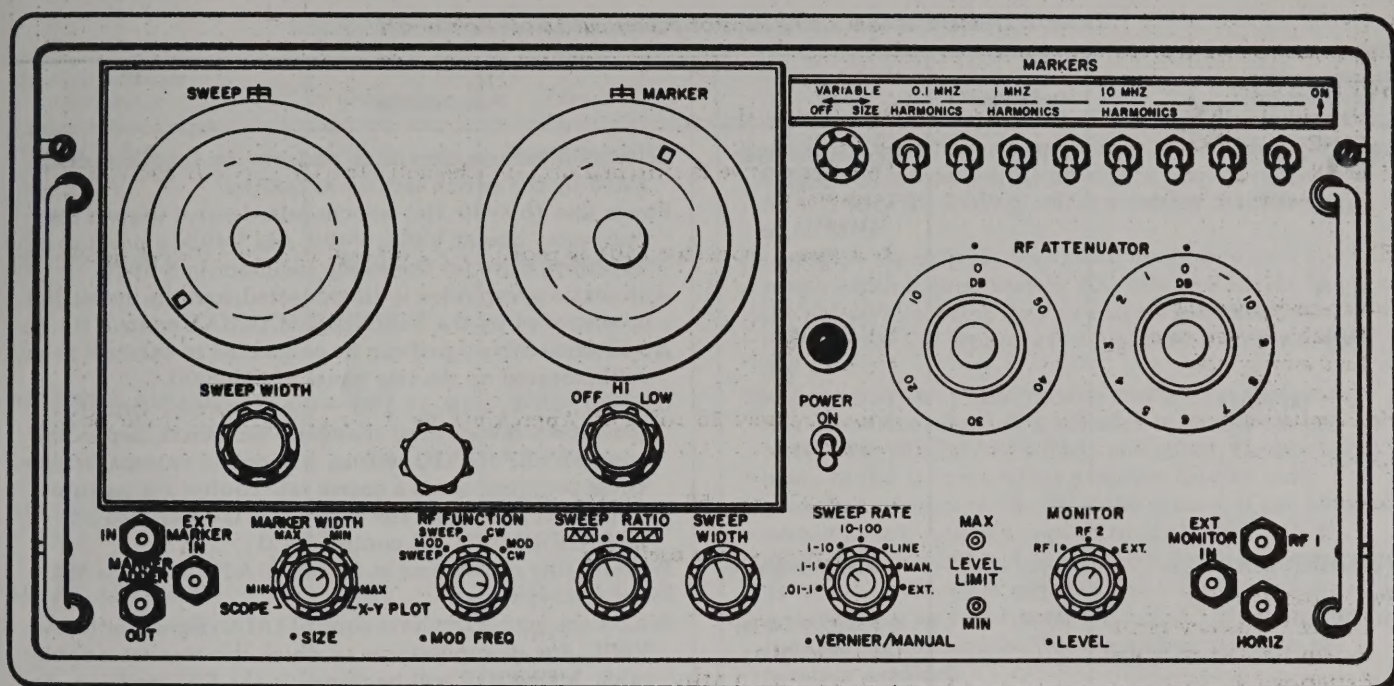


Figure 2-1. Sweep generator—front panel view.

Table 2-2. Front Panel Controls, Indicators, and Connectors

Control, indicator, or connector	Designator	Type	Function/Use
POWER ON	S101	2-position toggle switch	When set to up position, applies ac power to T101 power transformer.
RF FUNCTION	S403	4-position selector switch	Selects the operational modes designated by the switch functions as follows: Applies a blanking signal and a 1-kHz square wave to the B+ pass tube V304, which in turn controls the operating level of sweep oscillator. A sweep drive is supplied, which results in a swept RF output, modulated with the 1-kHz square wave. The return sweep is blanked. Supplies sweep drive and blanking signal. However, the 1-kHz square wave is disabled, and there is no modulation. The return sweep is blanked.
MOD SWEEP			In this mode, the SM-2000 is a conventional signal generator of fixed frequency, variable with SWEEP and SWEEP WIDTH controls on the S-100B.
SWEEP			Same as the CW mode except that the output is modulated with the 1-kHz square wave.
CW			Vernier control for the period of a cycle of the 1-kHz square wave generator V405. When modulation is used, this control is set for an oscillation frequency of 1-kHz. Most applications of the SM-2000 will not use the modulation mode of the RF FUNCTION switch; therefore, this control is generally disregarded.
MOD CW			Controls the sweep-to-retrace time ratio, providing a choice between a triangular or sawtooth sweep. When SWEEP RATE S401 is in LINE, MAN, or EXT position, this switch does not change the ratio.
MOD FREQ	R451	Variable resistor	Vernier control not used with the configuration to which this manual is applicable and consequently has no effect.
SWEEP RATIO	S402	2-position selector switch	
SWEEP WIDTH	R467 and R471	Variable resistor	

Table 2-2. Front Panel Controls, Indicators, and Connectors—Continued

Control, indicator or connector	Designator	Type	Function/Use
SWEEP RATE	S401	7-position selector switch	<p>Selects the various circuits to perform the functions designated by the switch settings as follows:</p> <p>Power line (50–60 Hz) synchronized signal triggers the “vari-rate” circuit V401, V402, and V403 to produce a waveform drive for the sweep oscillator in S-100B.</p> <p>Automatic sweep drive is disconnected, and the cw output is controlled by the VERNIER/MANUAL control R439. An external drive signal can be connected to external drive J401, located on the rear panel of SM-2000.</p> <p>0.01-0.1, 0.1-1, 1-10, 10-100 — the “vari-rate” circuit generates a sawtooth or triangular waveform, depending upon SWEEP RATIO setting, without an external trigger. These positions act as a coarse rate control for an automatic sweep control. The sweep rate is controlled by VERNIER/MANUAL control R421.</p>
LINE			
MAN			
EXT			
Four variables			
VERNIER/MANUAL	R421 and R439	Variable resistor	Provides fine adjustment in SWEEP RATE positions MAN and four variables.
MONITOR	S301	3-position selector switch	<p>Selects the automatic level control (ALC) signal for leveler V302. For all applications to which this manual is applicable, MONITOR will be placed in the RF1 position. At RF1, the ALC signal to V302 is detected by CR202 in the junction network and is proportional to the output sweep frequency level from the S-100B.</p> <p>RF2—this position is not used.</p> <p>EXT—this position connects to EXT MONITOR in J301.</p>
MONITOR LEVEL	R304	Variable resistor	Vernier control, along with LEVEL LIMIT MAX R303 and MIN R305, adjusts the level of the input to the attenuators and consequently to RF1 output jack. For general use, LEVEL LIMIT MAX and MIN are set fully cw, and MONITOR LEVEL is adjusted for midrange.
LEVEL LIMIT MAX	R303	Variable resistor	
LEVEL LIMIT MIN	R305	Variable resistor	
MARKER WIDTH	S510	8-position selector switch	Provides four different marker widths. The SCOPE MIN to MAX positions provide the non-rectified markers. The X-Y PLOT MIN to MAX positions provide the rectified markers, clipping the negative portions. The markers are applied to MARKER ADDER OUT J503.
MARKER WIDTH-SIZE	R533	Variable resistor	Vernier control. Adjusts the amplitude of all the markers.
RF ATTENUATOR	Z201 Z202		<p>Two turret attenuators in series which provide up to 60 db attenuation. The output is applied to RF1 (J212).</p> <p>Attenuator Z202 provides 0 to 50 db's in 10-db steps, and Z201 provides 0 to 10 db's in 1-db steps. The total attenuation is the sum of the two dial readings.</p>
Harmonic MARKERS		2-position toggle switches	Only three of these switches have any effect. The remaining five are unused.
0.1 MHz HARMONICS	S501	Toggle	Enables the 0.1-MHz marker chassis.
1 MHz HARMONICS	S503	Toggle	Enables the 1.0-MHz harmonic marker chassis.
10 MHz HARMONICS	S505	Toggle	Enables the 10.0-MHz harmonic marker chassis.
VARIABLE, OFF-SIZE	S509	Switch and variable resistor	Combination switch S509 and vernier control R511. Enables and adjusts the amplitude of the marker circuit in the S-100B. This control does not affect the fixed marker amplitude.
SWEEP			Located on the S-100B. Provides a calibrated dial control to vary the center sweep frequency between 0 and 50 MHz. If the SM-2000 is being used as a simple signal generator, this dial provides the CW frequency adjustment.
MARKER	C902	Variable capacitor	Located on the S-100B. Provides a calibrated dial control to vary the variable marker output from 0 to 125 MHz.

Table 2-2. Front Panel Controls, Indicators, and Connectors—Continued

Control, indicator or connector	Designator	Type	Function/Use
OFF-HI-LOW	S901	Selector switch	Enables the variable marker circuitry if VARIABLE OFF-SIZE S509 is enabled. HI provides a marker range from 50 to 125 MHz. LOW provides a marker range from 0 to 50 MHz.
SWEEP WIDTH	R602	Variable resistor	Located on the S-100B. Provides a method to vary the sweep width approximately 200 kHz to 70 MHz. If the SM-2000 is being used as a signal generator, this provides the CW frequency adjustment with the SWEEP dial.
MARKER ADDER OUT	J503	BNC connector	The fixed markers or the variable marker are applied to this connector after being adjusted in amplitude by MARKER WIDTH SIZE R532 and R533. Connection is made to this jack whenever a marker is to be used.
MARKER ADDER IN	J504	BNC connector	If a marker external to the SM-2000 is used, it can be connected to this jack and applied to MARKER ADDER OUT J503 through R534, a 47,000-ohm isolation resistor.
EXT MARKER IN	J211	BNC connector	Any external CW signal being used as a marker is fed to this connector. A signal between 0.01- and 1.0-volt amplitude would be suitable. This connector routes to the junction network.
EXT MONITOR IN	J301	BNC connector	Connects to EXT position of the MONITOR switch and would be used if an external ALC were to be applied.
HORIZ	J402	BNC connector	Applies a triangular or sawtooth waveform for synchronizing or driving the horizontal deflection circuitry of external equipment such as oscilloscopes.
RF1	J212	BNC connector	The output jack from which the RF signals or RF sweep voltages are taken for use on units being tested. This jack connects directly to ATTENUATOR 0-10 DB, Z201.

Table 2-3. Rear Panel Indicators and Connectors

Indicator or connector	Designator	Type	Function/Use
Fuse	F101		A 3-amp delay action fuse for 115-volt operation. A 1.5-amp delay action for 230-volt operation.
Power cord		3-wire	Should be used only with 50 — 60 Hz power source of 115 or 230 volts.
Ext drive	J401	Single banana jack	This jack is not labeled on the equipment; however, for the sake of identification in the text and the schematics, it is called Ext Drive. This connects to the EXT position of SWEEP RATE S401 and would be used if the sweep of the SM-2000X11-1 were to be driven with an external source. To provide free sweep width and proper operation, the external drive should be 100 volts P/P at 70-vdc reference. A common ground between the SM-2000X11-1 and the external source would have to be made separately.

CHAPTER 3

OPERATION

Section I. GENERAL

3-1. Preparations Before Energizing

Before energizing the sweep generator, certain conditions must be established relating to the power source to be used. These requirements of voltage, frequency, and fusing are described below.

3-2. Voltage Requirements

a. Use either 115 or 230 volts to operate the sweep generator.

b. Set S102 to either the 115-volt or 230-volt position, depending on the power source to be used. The switch is located inside the case near the power transformer.

3-3. Frequency Requirements

a. The sweep generator operates on a power frequency of 50-to-60 Hz.

b. Check the power source to be used to assure that the frequency is within this range.

3-4. Fusing Requirements

a. For 115-volt operation, the sweep generator requires a 3-amp fuse. For 230-volt operation, a 1.5-amp fuse is required.

b. Check that the fuse (F101) corresponds with the line voltage to be used.

3-5. Energizing the Sweep Generator

To energize the sweep generator, connect the power cord to a power source that matches the voltage, frequency, and fuse conditions, and set the POWER toggle switch to ON.

CAUTION

Remove power from the sweep generator before inserting or removing plug-in units.

Section II. OPERATIONAL CHECKS AND ADJUSTMENTS

3-6. General

a. Operational checks and adjustments assure that the sweep generator will operate properly. If normal indications are not obtained, refer to troubleshooting procedures in section IV.

b. By using a Dumont 765 oscilloscope and the voltmeter in electronic Shop 3, most of the operational checks and adjustments can be accurately performed. The checks can be used as aids in troubleshooting and for resetting affected circuitry after parts are replaced.

c. The frequency harmonics of the marker generators and the RF sweep frequency ranges cannot be accurately tested with the oscilloscope and voltmeter. Certain means can be used, however, by the technician to compare signals that provide a fairly reliable check.

d. For instance, with RF FUNCTION switch set to CW, the 10 MHz switch set to ON, and RF1 and MARKER ADDER OUT added on the

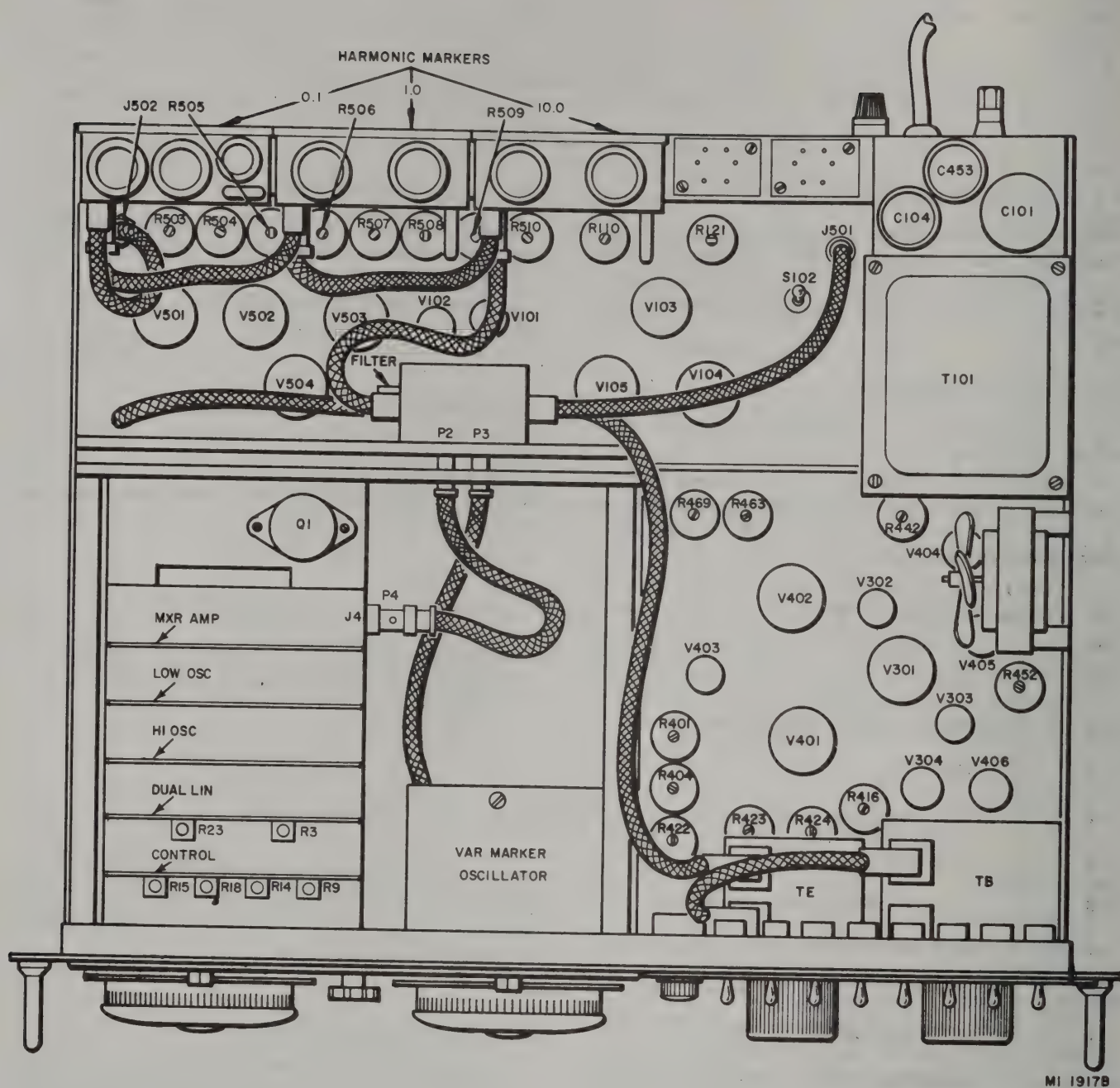
oscilloscope, it can be observed that the waveform beats every 10 MHz as SWEEP is slowly rotated. Other such methods of testing can be devised by the technician.

3-7. Checks and Adjustments

a. Checks and adjustments for five circuits are described in the following paragraphs. These circuits are the power supply, variable rate circuit, reactor drive, modulation circuit, and marker circuits.

b. The operational checks consist of a series of steps which should be performed in sequence. The operations to be performed and the normal indications to be observed are listed. If an indication other than a normal indication occurs, correct the malfunction before proceeding.

c. To locate components requiring adjustments refer to figure 3-1.



MI 1917B

Figure 3-1. Sweep generator—locational view from top of chassis.

3-8. Power Supply


b. Using the HP-3403C voltmeter, check for the following normal indications with the test leads connected between pins of J601 and frame ground as shown below:

a. Energize the sweep generator.

Step	Connect		Normal indication
	From	To	
1	J601-12 (neg)	Ground	-149 \pm 9 vdc (There is no adjustment.)
2	J601-13 (neg)	Ground	-187 \pm 3 vdc (There is no adjustment.)
3	J601-3 (pos)	Ground	350 \pm 15 vdc (There is no adjustment. This voltage is not used directly, but checks the selective condition of CR101 and CR102 for B+ to V103, V104, and V105.)
4	J601-4 (pos)	Ground	175 \pm 2 vdc (Adjust R110 (B+2), if necessary.)
5	J601-5 (pos)	Ground	100 \pm 1 vdc (Adjust R121 (B+3), if necessary.)

3-9. Variable Rate Circuit


a. Perform the following operations:

Step	SM-2000 control	Operation
1	POWER ON switch	Set to ON.
2	SWEEP RATE selector switch	Set to 10-100.
3	VERNIER/MANUAL control	Rotate fully cw.
4	RF FUNCTION selector switch	Set to SWEEP.
5	VARIABLE, OFF-SIZE switch	Rotate fully cw.
6	MARKER WIDTH selector switch	Set to SCOPE-MAX.
7	MARKER WIDTH-SIZE	Rotate fully cw.
8	SWEEP RATIO selector switch	Set to 
9	MONITOR selector switch	Set to RF1.
10	MONITOR LEVEL control	Rotate fully cw.
11	LEVEL LIMIT-MAX control	Rotate fully cw.
12	RF ATTENUATOR controls	Set both dials to 0 DB.
13	MARKERS switches	Set all switches to down position.

b. Perform the following operations on the S-100B.

Step	S-100B control	Operation
1	OFF-HI-LOW selector switch	Set to LOW.
2	SWEEP control	Rotate to 10 MHz.
3	MARKER control	Rotate to 10 on red dial.
4	SWEEP WIDTH control	Rotate to midrange.

c. Perform the following checks and adjustments:

Step	Control	Operation	Normal indication
1	TRIGGER BIAS R404	Rotate slightly ccw.	The two neon bulbs near R404 shall go out as rotation is made ccw, and the oscilloscope pattern shall disappear.
2	TRIGGER BIAS R404	Rotate until the two neon bulbs just begin to glow and the oscilloscope pattern reappears. Continue the adjustment slightly until oscilloscope pattern is stable and not distorted.	
3	TRIGGER AMPLITUDE R401	Adjust for a waveform of 100 volts peak-to-peak.	The level shall indicate +70 volts.
4		Check the dc level with the oscilloscope by setting the DC-AC-GND switch from AC to DC. If +70 volts is not attained, re-adjust R404 for +70 volts, and recheck the peak-to-peak amplitude. Continue adjusting R401 for 100 volts peak-to-peak and R404 for +70 volts DC level until both conditions are met without further adjustment.	
5		Insure that VERNIER/MANUAL is fully cw and SWEEP RATE is 10-100.	
6	SWEEP PERIOD R423	Adjust for exactly 5-millisecond duration of the positive-going position of the waveform. Now adjust RETRACE PERIOD R416 for exactly 5-millisecond duration of the negative going portion of the waveform. Repeat both adjustments until limits are met without further adjustment.	
7	SWEEP RATE selector switch	Set to LINE.	
8	LINE SIZE R422	Adjust for 100 volts peak-to-peak.	
9	SWEEP RATE selector switch	Set to 10-100, and insure that VERNIER/MANUAL is fully cw.	
10	SWEEP RATIO selector switch	Set to  . Adjust SWEEP PERIOD R424 for a sawtooth of 10-millisecond total duration (i.e., both the rise and fall time). Note. Resistor R479 is part of the variable rate circuit; however, it is not to be adjusted. If the resistor is replaced, set it to midrange, and perform the adjustment for the variable rate circuit.	

3-10. Reactor Drive Circuit

a. The reactor drive includes CENT MAX SWEEP R463, CENT MIN SWEEP R469, and SWEEP WIDTH (front panel).

b. Because this circuit is not used with the S-100B, adjustment of these controls have no

effect and no adjustment is required.

3-11. Modulation Circuit

a. Energize the sweep generator.

b. Perform the following operations:

Step	Control	Operation	Normal indication
1	RF FUNCTION selector switch	Set to MOD SWEEP and to midrange as exactly as possible.	
2	SWEEP RATE selector switch	Set to 10-100 position.	
3	VERNIER/MANUAL control	Set to midrange.	
4	Oscilloscope	Connect probe to J601-31.	A square wave pattern approximately 175 volts peak-to-peak shall be present. The period of 1 Hz shall be 1 ms.
5		For a more accurate measurement, use the 2 ms sweep range on the oscilloscope.	Observe that there are exactly 20 pulses covering 10 major divisions. If necessary, adjust MOD FREQ LIMIT R452.

3-12. Marker Circuitry

a. Three variable resistors located on the main-frame control the three harmonic markers. The resistors and their corresponding markers are as follows:

- | | |
|-------------------|-----------------|
| (1) MARKER SIZE 2 | 0.1 MHz marker |
| (R504) | |
| (2) MARKER SIZE 3 | 1.0 MHz marker |
| (R505) | |
| (3) MARKER SIZE 5 | 10.0 MHz marker |
| (R507) | |

The other marker-size controls are not used and have no effect.

b. The markers can be varied in amplitude with front panel control MARKER WIDTH-SIZE anytime the markers are being used. It is recommended that MARKER SIZE 2, 3, and 5 be set fully cw for normal operation.

c. If tests using the sweep generator require changing the marker amplitude, adjust MARKER WIDTH-SIZE on the front panel.

d. When monitoring the markers, it can be observed that the 0.1-MHz markers are much smaller in amplitude than both the 1-MHz and 10-MHz markers. This is normal.

Section III. OPERATING PROCEDURES

3-13. General

a. Operating procedures include use of the sweep generator in the sweep mode and CW mode. These procedures enable the user to adjust the sweep generator for desired sweep widths, bandwidth checks, center frequency locations, and other operations.


b. The setups described are typical and are not to be construed as the only methods by which the

sweep generator can be used on IF amplifiers and IF discriminators.

3-14. Preparation for Operation

a. Inspect the sweep generator to assure that all wiring and components are properly positioned, secured, and undamaged.

b. Perform the following operations:

Step	Control	Operation
1	POWER ON switch	Set to ON.
2	RF ATTENUATOR controls	Set both controls to 0 DB.
3	MARKERS switches	Set all switches to down position.
4	VARIABLE, OFF-SIZE switch	Rotate fully cw.
5	RF FUNCTION selector switch	Set to SWEEP.
6	SWEEP RATIO selector switch	Set to 
7	SWEEP RATE selector switch	Set to LINE.
8	LEVEL LIMIT-MAX/MIN controls	Set fully cw.
9	MONITOR selector switch	Set to RF1.
10	MONITOR LEVEL control	Rotate fully cw.
11	SWEEP WIDTH control (on S-100B)	Rotate fully cw.
12	OFF-HI-LOW selector switch	Set to OFF.
13	Oscilloscope	Energize and adjust for sweep time of 2 ms, using external sync source, with vertical mode switch at added mode.

c. Make the following connections:

Cable	From	On	To	On
Coax	MARKER ADDER OUT	SM-2000	Vertical input jack	Oscilloscope
Coax	RF1	SM-2000	Remaining vertical input jack	Oscilloscope
Coax	HORIZ	SM-2000	External sync jack	Oscilloscope

3-15. Sweep Operation

a. Adjust for a 50-70 MHz sweep as follows:

Step	Control	Operation	Normal indication
1	SWEEP control on the S-100B	Set to 60. This is the arithmetic center of a 50-70 sweep.	An RF sweep is present on the scope. Disregard its shape at this time. Five or more markers appear on the waveform.
2	MARKER control on	Set to 60.	
3	10MHz HARMONICS switch	Set to ON.	
4	LEVEL LIMIT MAX and MIN controls	Adjust to "square up" the waveform. These controls will be adjusted again later for the desired output amplitude.	A 20-MHz sweep width is now established (70 minus 50 equals 20).
5	SWEEP WIDTH control on the S-100B	Rotate ccw until only three markers are on the waveform.	
6	SWEEP and SWEEP WIDTH controls	Adjust each in turn until only one marker is at the beginning, one in the center, and one at the very end of the waveform.	

Step	Control	Operation	Normal indication
7	10 MHz HARMONICS	Set to down position.	The variable marker should be present on the waveform.
8	OFF-HI-LOW selector switch	Set to HI. If the variable marker is not present, adjust SWEEP until it is visible. Now adjust SWEEP until the variable marker is approximately centered on the waveform.	
9	OFF-HI-LOW selector switch	Set to OFF.	
10	10 MHz HARMONICS switch	Set to ON.	A 50- to 70-MHz sweep is now established, centered at 60 MHz.
11	SWEEP control	Adjust slightly, if necessary, to again obtain the three markers at the beginning, middle, and end of the waveform.	
12	LEVEL LIMIT MAX and MIN controls	Adjust for the desired amplitude, not counting the 10-MHz markers. If the frequency shifts, repeat steps 5 and 6 above. Place the 10-MHz HARMONICS switch to the down position.	
<p style="text-align: center;">NOTE</p> <p>Some procedures may require a 0.7-vac amplitude, as read on a VTVM. In these cases, multiply the 0.7 vac times 1.414. This equals approximately 1 volt. Adjust the SM-2000 for 1-volt amplitude on the oscilloscope.</p>			

b. Adjust for a 10-20 MHz sweep as follows:

Step	Control	Operation	Normal indication
1		Place the controls to the positions outlined in paragraph 3-14.	An RF sweep is present on the scope. Disregard its shape at this time. Five or more markers appear on the waveform.
2	SWEEP controls on the S-100B	Set to 15. This is a arithmetic center to 10-20 sweep.	
3	MARKER control on the S-100B	Set to 15.	
4	10 MHz HARMONICS switch	Set to ON.	A 10-MHz sweep width is now established (20 minus 10 equals 10).
5	LEVEL LIMIT MAX control	Adjust to "square up" the waveform. These controls will be adjusted again later for the desired output amplitude.	
6	SWEEP WIDTH control on the S-100B	Rotate ccw until only two markers are on the waveform.	
7	SWEEP and SWEEP WIDTH controls	Adjust in turn until a marker is at the beginning and one at the very end of the waveform.	The variable marker should be present on the waveform.
8	10 MHz HARMONICS switch	Set to down position.	
9	OFF-HI-LOW selector switch	Set to LOW. If the variable marker is not present, adjust SWEEP until it is visible. Now adjust SWEEP until the variable marker is approximately centered on the waveform.	
10	OFF-HI-LOW selector switch	Set to OFF.	A 10- to 20-MHz sweep is now established that is centered at 15 MHz.
11	10 MHz HARMONICS switch	Set to ON.	
12		Adjust SWEEP slightly, if necessary, to again obtain the two markers, one at the beginning and the one at the end, of the waveform.	

Step	Control	Operation	Normal indication
13	LEVEL LIMIT MAX and MIN controls	Adjust for the desired amplitude, not counting the 10-MHz markers. If the frequency shifts, repeat steps 6 and 7 above. Place the 10-MHz HARMONICS switch to the down position.	

c. At the completion of paragraph *a* or *b*, the sweep generator is ready to provide either the 50-70 or 10-20 MHz sweep. The sweep is taken out at connector RF1. The markers are taken from MARKER ADDER OUT. The waveform from HORIZ can be used either to synchronize an oscilloscope or drive its horizontal plates.

d. The variable marker is used by placing OFF-HI-LOW to HI for 50-70-MHz sweeps or LOW for 10-20 MHz sweeps, and reading the MARKER dial directly.

e. For 3-dB reference checks, insert or remove 3 dBs with the 0.10 DB RF ATTENUATOR.

3-16. CW Operation

a. The sweep generator may be adjusted for a fixed CW signal by using a counter or an oscilloscope. The adjustment is simplified using a counter, as described in *b*. If a counter is not available, use an oscilloscope as described in *c*.

b. Using a counter, adjust for a CW signal as follows:

Step	Control	Operation
1		Connect a coax cable from RF1 on the sweep generator to the counter.
2	RF FUNCTION selector switch	Set to CW.
3	SWEEP control and SWEEP WIDTH control	Adjust to obtain the desired frequency as indicated on the counter.

c. Using an oscilloscope, adjust for a fixed CW signal as follows:

Step	Control	Operation
1	RF FUNCTION selector switch	Set to CW.
2	MARKER WIDTH selector switch	Set to SCOPE MAX.
3	SWEEP control	Set to 60 (or 15).
4	SWEEP WIDTH control	Rotate fully ccw.
5	MARKER control	Set exactly to 60 (or exactly 15).
6	OFF-HI-LOW selector switch	Set to HI (or LOW if 15 MHz is desired).
7	VARIABLE, OFF-SIZE control	Rotate fully cw.
8	MARKER WIDTH-SIZE control	Rotate fully cw.
9		Connect to coax cable from the oscilloscope to MARKER ADDER OUT.

Step	Control	Operation
10	Oscilloscope	Energize and adjust for 2 ms sweep time, internal (signal) trigger source, and use 2V/DIV vertical scale. A straight line is visible if HF RECUR is used when synchronizing the oscilloscope.
11	SWEEP control	Rotate cw very slowly until a waveform of at least 5 volts is present.
12	SWEEP control	Continue rotating slowly. The amplitude will decrease, then increase again.
13	SWEEP and SWEEP WIDTH controls	Adjust to obtain the minimum amplitude between the two maximums. The CW signal is now set to the desired frequency at the accuracy of the MARKER dial.
14	LEVEL LIMIT, MAX and MIN	While monitoring the CW output at RF1, adjust for the desired amplitude. LEVEL LIMIT adjustment will shift the frequency, so repeat adjustment at MARKER ADDER OUT with SWEEP.
15	SWEEP and SWEEP WIDTH controls	Adjustment of LEVEL LIMIT in step 14 will shift the frequency, requiring repeat adjustment at MARKER ADDER OUT with SWEEP and SWEEP WIDTH controls.

3-17. Other Sweep Generator Uses

a. Sometimes IF equipment will have higher gain at other than the designed frequency range. The sweep generator can be used to determine these other frequencies.

b. With the IF amplifier in the circuit, adjust SWEEP or SWEEP WIDTH controls for the maximum output.

c. Then connect an oscilloscope to MARKER ADDER OUT, and without adjusting SWEEP or SWEEP WIDTH controls, adjust MARKER for the signal selected in 3-16c(3). (OFF-HI-LOW must be set to the appropriate setting.)

d. The MARKER dial can be read directly as the optimum frequency for the IF amplifier being tested.

Section IV. TROUBLESHOOTING

3-18. Use of Waveforms

a. Troubleshooting the sweep generator is based on comparing waveforms at various test points with the typical waveforms shown in figure 3-2. Test points (TP) in the schematic diagrams are identified by circled numbers. These same TP numbers identify the corresponding illustrated waveforms.

b. To troubleshoot the sweep generator, refer first to the functional schematic figure 4-1. Compare the waveforms to isolate the malfunction to the subassembly level. Then proceed to the individual subassembly schematic to determine the faulty component.

c. Waveforms shown are typical patterns for the sweep generator in proper operating condition and will not necessarily be duplicated exactly on all sweep generators.

3-19. Waveform Checks


a. To perform the waveform checks, the controls on the sweep generator must be set to the positions outlined below. For all waveforms, use the Dumont 765 oscilloscope with the 10X attenuator probe unless a different probe is indicated in the illustration.

b. Oscilloscope settings for the sync source, sweep time, and vertical attenuation are provided with each waveform. For example: TP9 requires an EXT sync, SLOPE switch set to +, a 2-ms sweep time, and a 5 VOLTS/DIVISION vertical attenuation. Observe that the TP9 waveform is

slightly more than 8 ms wide and about 19 volts in amplitude with the 10X probe being used.

3-20. Preparation for Checks

a. Set the controls on the sweep generator as follows:

Step	Control	Operation
1	POWER ON switch	Set to ON.
2	SWEEP RATE selector switch	Set to LINE.
3	RF FUNCTION selector switch	Set to SWEEP.
4	VARIABLE, OFF—SIZE	Rotate fully cw.
5	MARKER WIDTH—SIZE	Rotate fully cw.
6	MARKER WIDTH selector switch	Set to SCOPE—MAX.
7	SWEEP RATIO selector switch	Set to 
8	MONITOR selector switch	Set to RF1.
9	MONITOR LEVEL control	Rotate fully cw.
10	LEVEL LIMIT—MAX	Rotate fully cw.
11	LEVEL LIMIT—MIN	Rotate fully cw.
12	RF ATTENUATOR controls	Set both dials to 0 DB.
13	MARKERS switches	Set all switches to down position.
14	OFF—HI—LOW selector switch	Set to LOW.
15	SWEEP control	Rotate to 10 MHz.
16	MARKER control	Rotate to 10 on red dial.
17	SWEEP WIDTH control	Rotate to midrange.

b. Connect a coaxial cable from HORIZ on the sweep generator to the external trigger (sync) jack on the oscilloscope. Synchronizing the oscilloscope with the signal from HORIZ provides the most stable viewing of the waveforms. Internal synchronization may be used if the HORIZ channel is inoperable.

3-21. Schematic Component Values

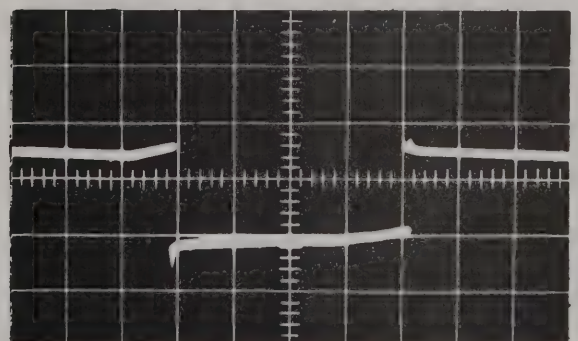
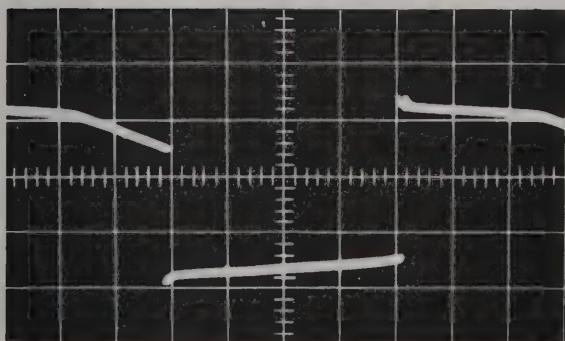
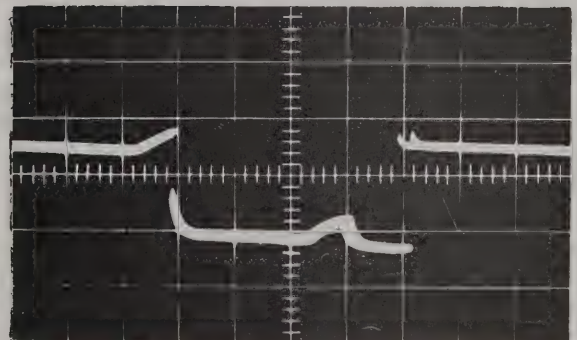
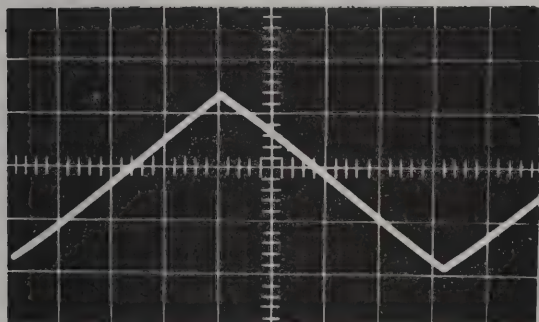
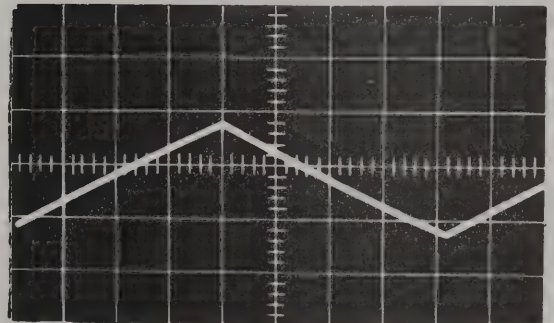
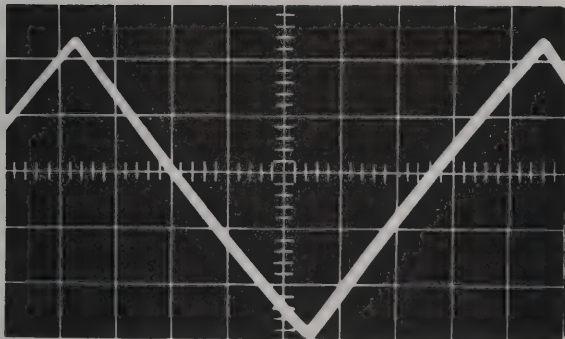
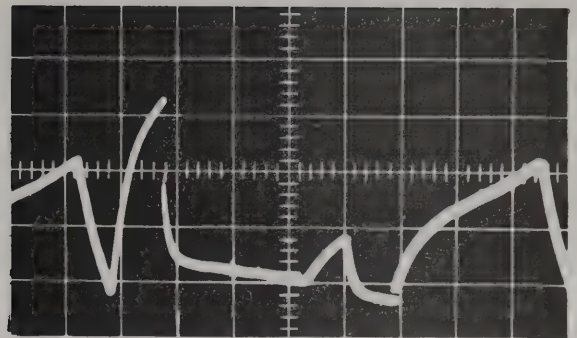
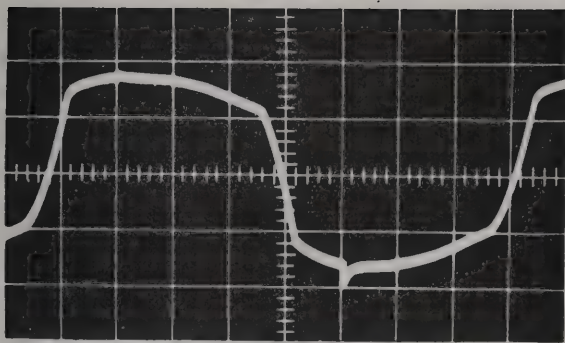
a. All resistors are 1/2 watt $\pm 1\%$ and are shown in ohms (Ω) unless otherwise specified.

b. All capacitors are shown in picofarads (pf) unless otherwise specified.

c. All inductors are shown in microhenries (μh) unless otherwise specified.

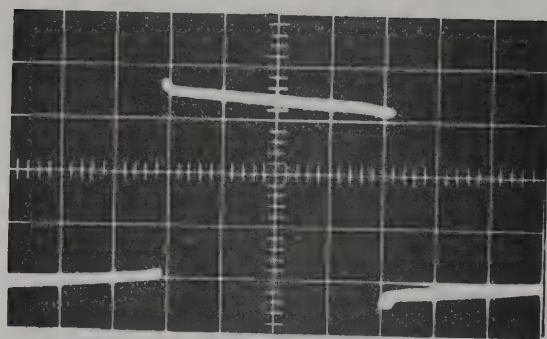
d. All starred (*) values were selected at the time of manufacturer.

e. Resistors in the attenuator pads are $\pm 1\%$.

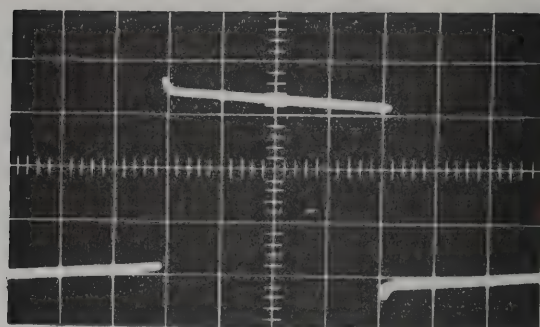


MI 1886

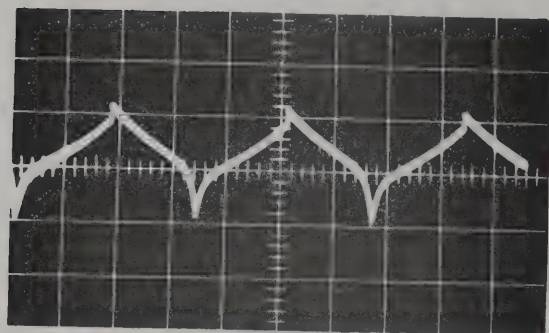
Figure 3-2. Typical waveforms at SM-2000 test points (Sheet 1 of 7).



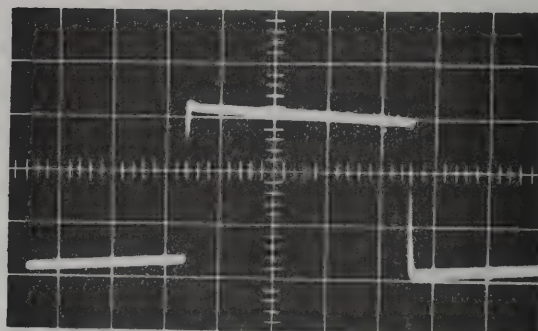
TP9 5V/DIV
2msec EXT + SLOPE



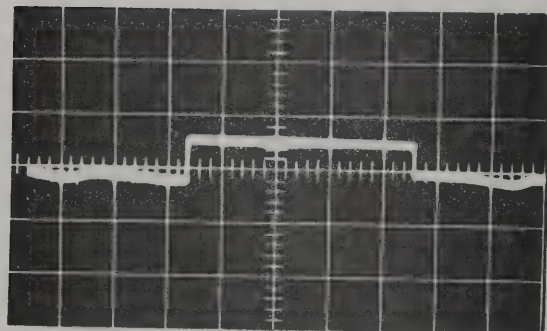
TP10 2V/DIV
2msec EXT + SLOPE



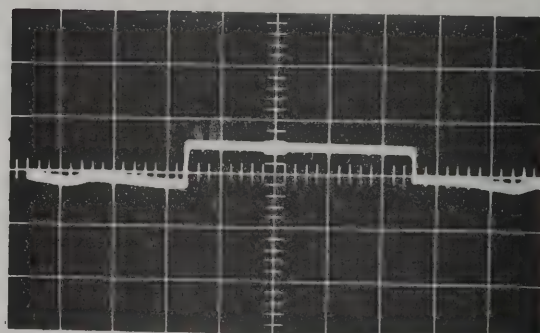
TP11 0.1V/DIV
5msec EXT + SLOPE



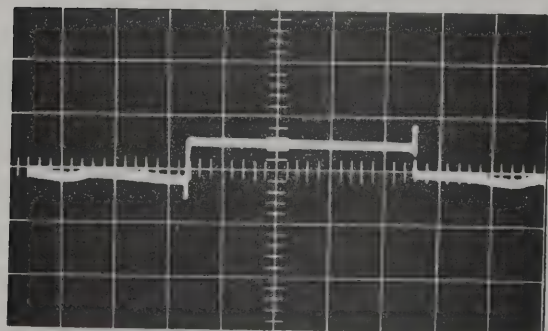
TP12 2V/DIV
2msec EXT + SLOPE



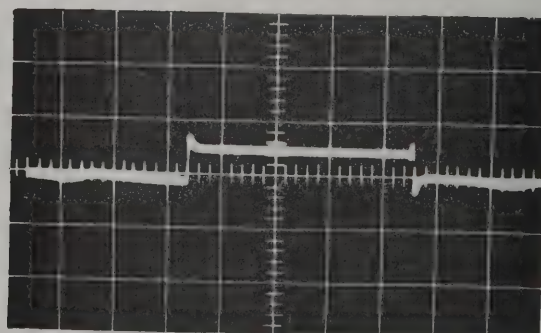
TP13 0.1V/DIV
2msec EXT + SLOPE



TP14 0.1V/DIV
2msec EXT + SLOPE



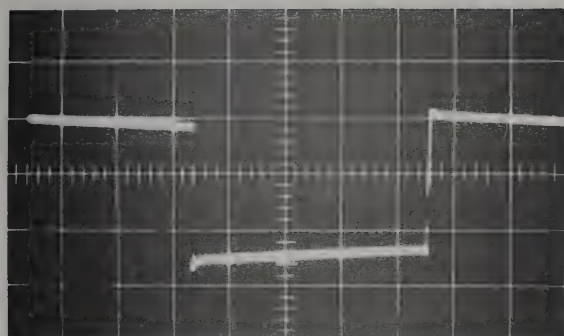
TP15 0.1V/DIV
2msec EXT + SLOPE



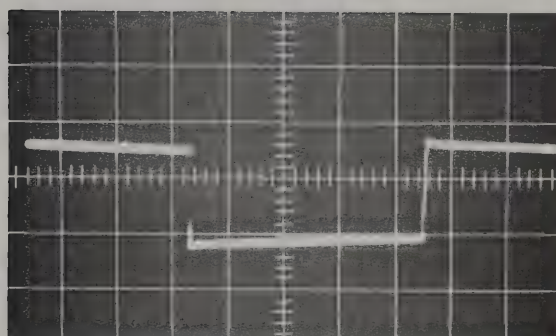
TP16 0.1V/DIV
2msec EXT + SLOPE

Figure 3-2. Typical waveforms at SM-2000 test points (Sheet 2 of 7).

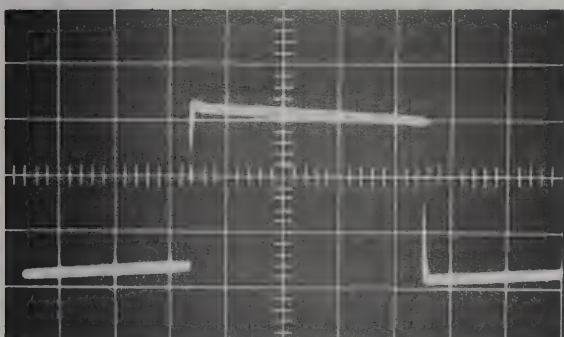
MI 1887



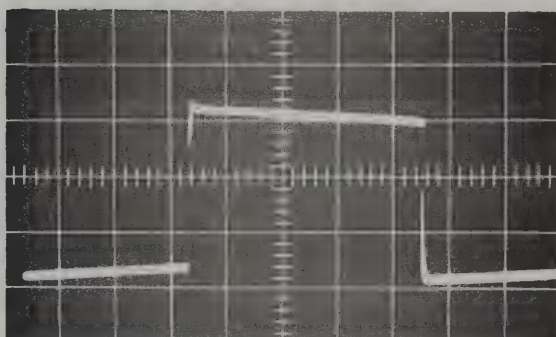
TP17 10V/DIV
2msec EXT + SLOPE



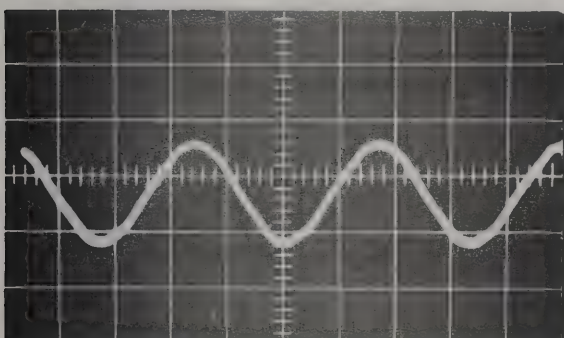
TP18 10V/DIV
2msec EXT + SLOPE



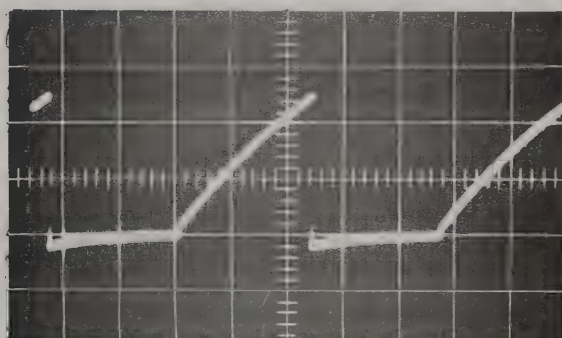
TP19 2V/DIV
2msec EXT + SLOPE



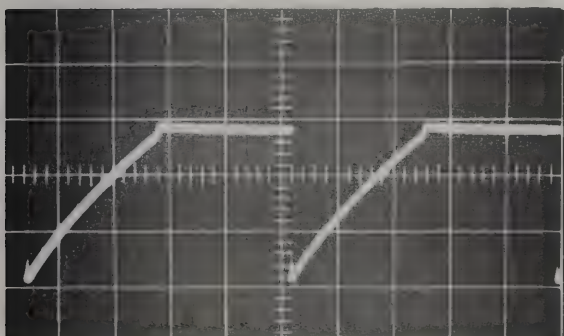
TP20 2V/DIV
2msec EXT + SLOPE



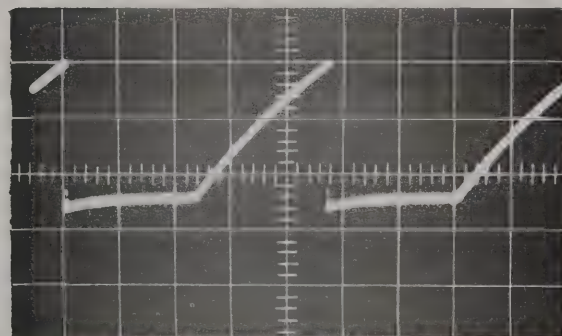
TP21 1V/DIV
5msec EXT + SLOPE



TP22 5V/DIV 0.2msec INT + SLOPE
Set RF FUNCTION to MOD SWEEP.



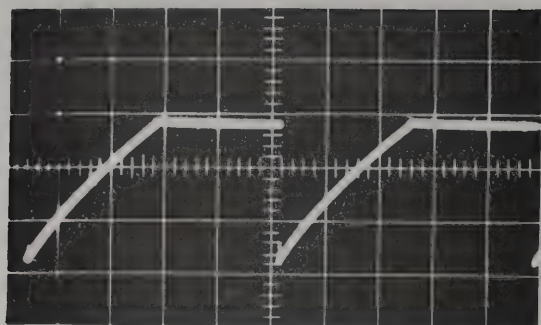
TP23 5V/DIV 0.2msec INT - SLOPE
Set RF FUNCTION to MOD SWEEP.



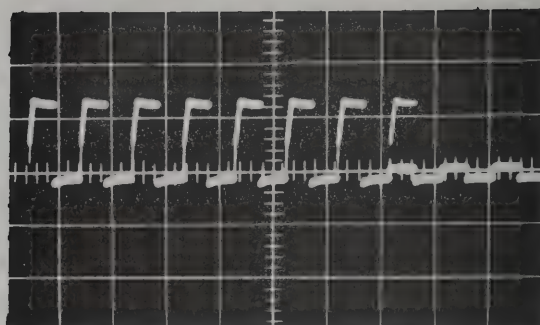
TP24 5V/DIV 0.2msec INT + SLOPE
Set RF FUNCTION to MOD SWEEP.

MI 1888

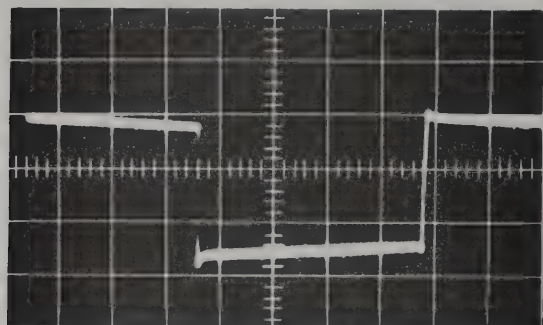
Figure 3-2. Typical waveforms at SM-2000 test points (Sheet 3 of 7).



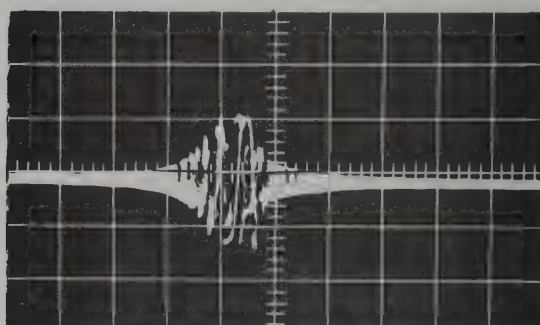
TP25 5V/DIV 0.2msec INT - SLOPE
Set RF FUNCTION to MOD SWEEP.



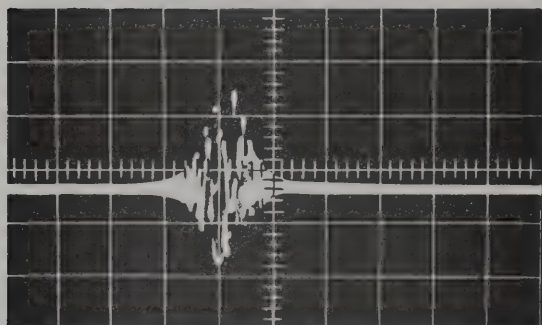
TP26 20V/DIV 1msec INT + SLOPE
Set RF FUNCTION to MOD SWEEP.



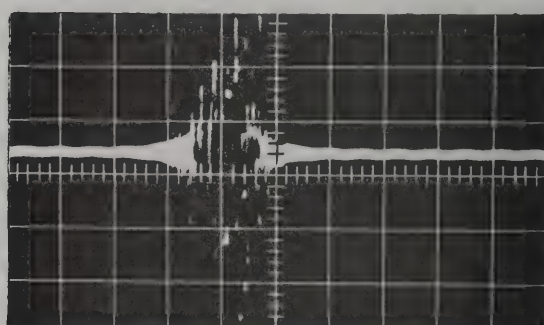
TP26 10V/DIV
2msec EXT + SLOPE



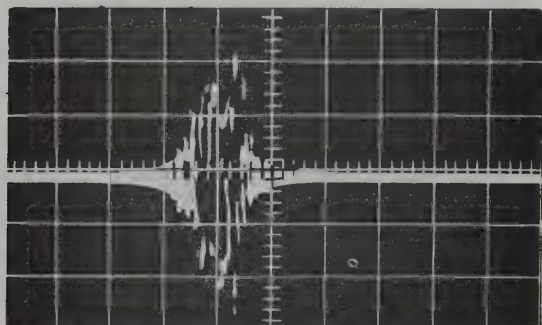
TP29 0.1V/DIV 50usec
EXT + SLOPE Use 1:1 probe.



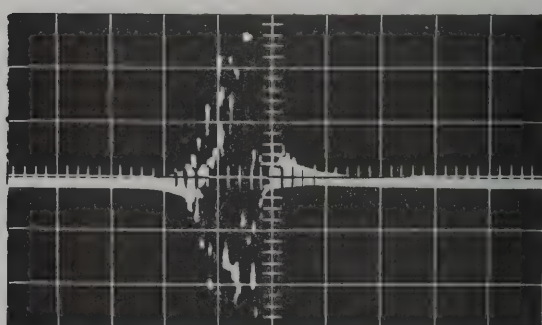
TP30 0.2V/DIV
50usec EXT + SLOPE



TP31 0.1V/DIV 50usec
EXT + SLOPE Use 1:1 probe.



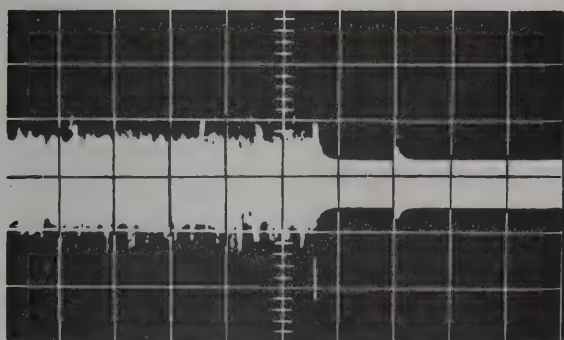
TP32 0.1V/DIV
50usec EXT + SLOPE



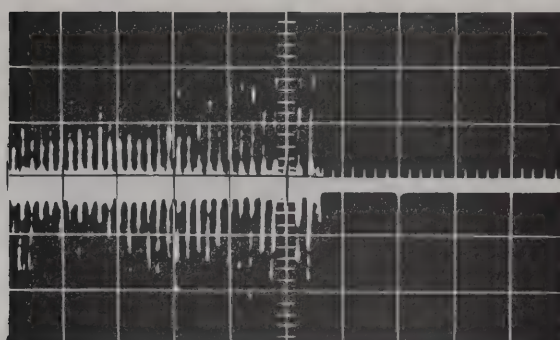
TP33 0.5V/DIV
50usec EXT + SLOPE

MI 1889

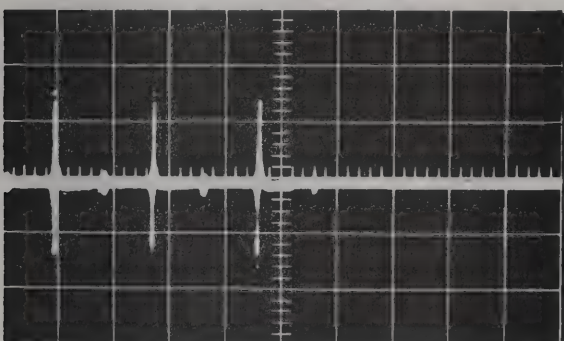
Figure 3-2. Typical waveforms at SM-2000 test points (Sheet 4 of 7).



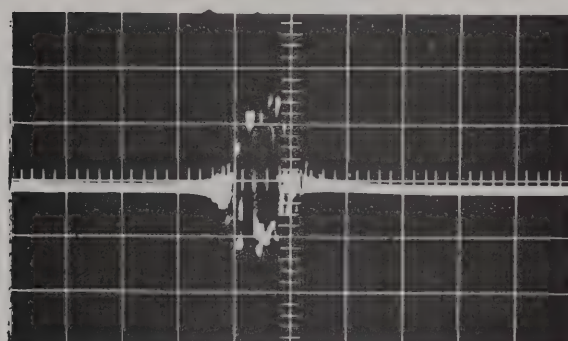
TP34 1V/DIV 1msec EXT + SLOPE Use coax cable from MARKER ADDER OUT to scope. 0.1 MHz switch to ON. OFF-HI-LO to OFF.



TP34 1V/DIV 1msec EXT + SLOPE Use coax cable from MARKER ADDER OUT to scope. 1 MHz to ON. OFF-HI-LO to OFF.



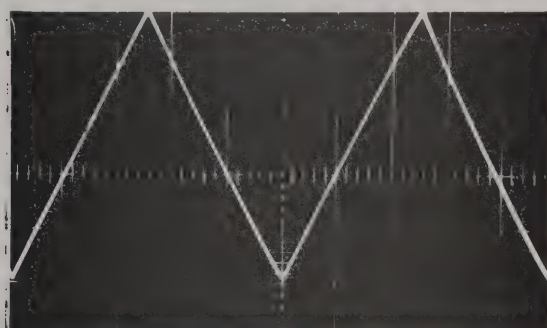
TP34 2V/DIV 1msec EXT + SLOPE Use coax cable from MARKER ADDER OUT to scope. 10 MHz switch to ON. OFF-HI-LO to OFF.



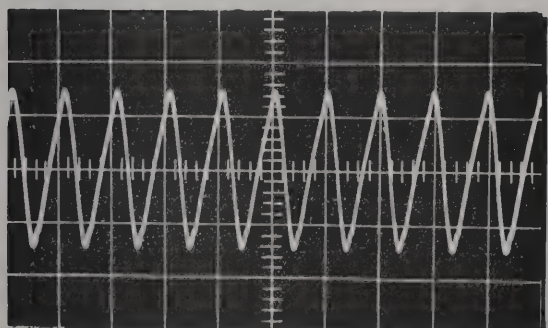
TP34 2V/DIV 50usec EXT + SLOPE Adjust LEVEL on scope to obtain pattern. Use coax cable from MARKER ADDER OUT to scope. OFF-HI-LO to LO. VARIABLE-OFF-SIZE fully CW.



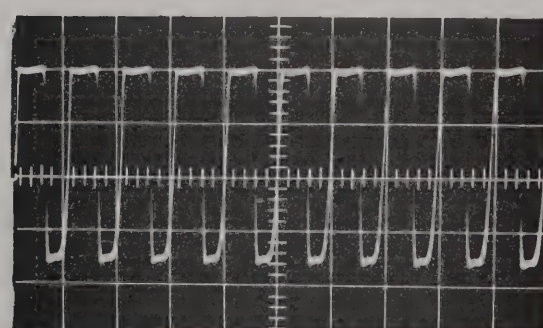
J601-28 2V/DIV 2msec INT + SLOPE Set SWEEP RATIO to $\square\square$.



J601-28 2V/DIV 2msec INT + SLOPE Set SWEEP RATIO to $\square\square$.



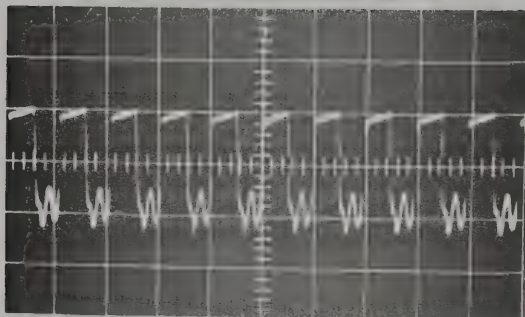
0.1 MHz TP1 0.1V/DIV 10usec INT + SLOPE Use 1:1 probe.



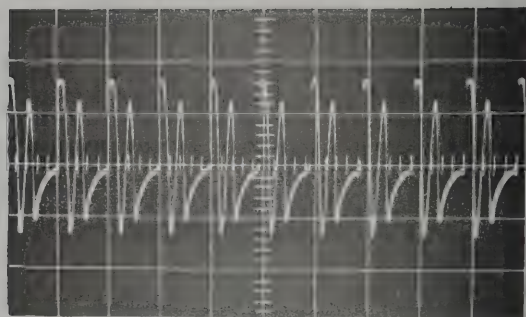
0.1 MHz V501-5 1V/DIV 10usec INT + SLOPE

MI 1890

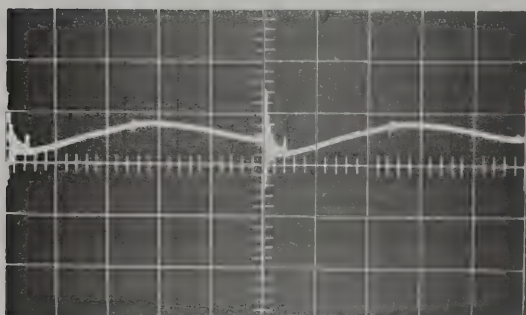
Figure 3-2. Typical waveforms at SM-2000 test points (Sheet 5 of 7).



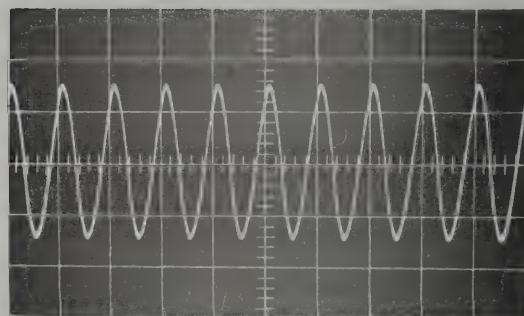
0.1 MHz V502-1 1V/DIV
10usec INT + SLOPE



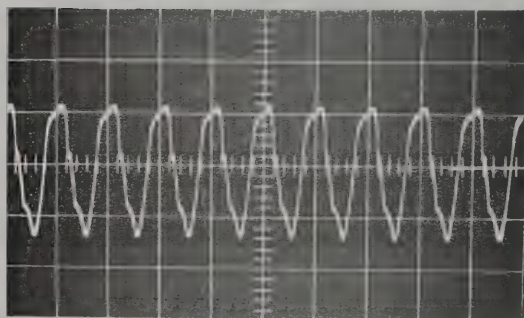
0.1 MHz V502-6 10V/DIV
10usec INT + SLOPE



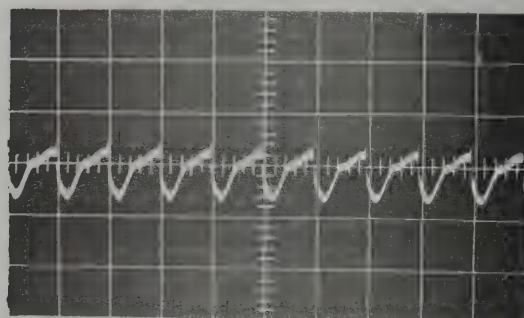
0.1 MHz V503-1 0.2V/DIV
2usec INT + SLOPE



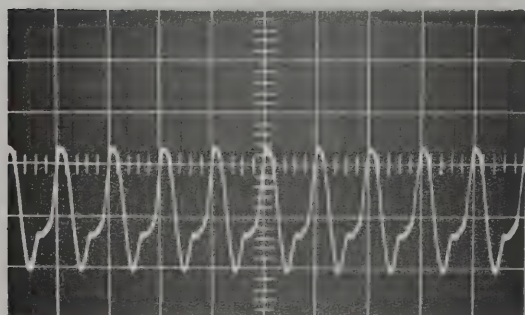
1.0 MHz V501-2 0.5V/DIV
1usec INT + SLOPE



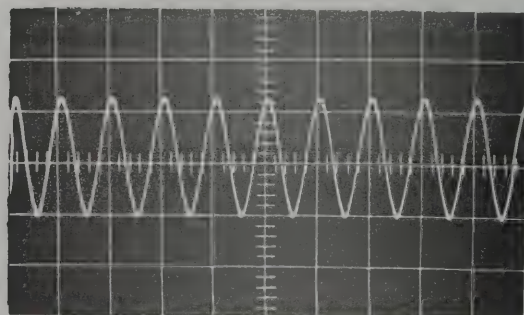
1.0 MHz V501-9 0.5V/DIV
1usec INT + SLOPE



1.0 MHz V502-6 0.1V/DIV 1usec
INT + SLOPE Use 1:1 probe.



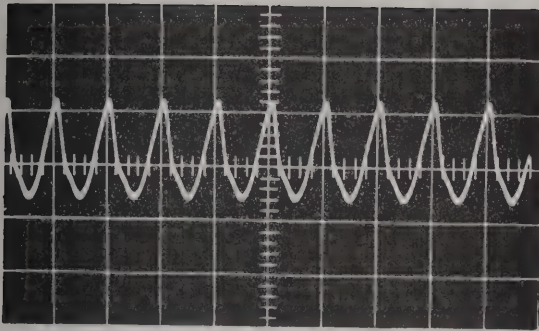
1.0 MHz V502-2 5V/DIV
1usec INT + SLOPE



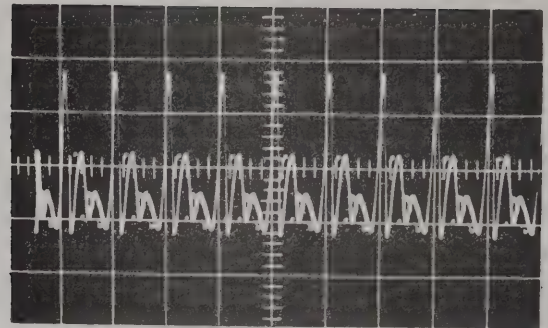
10.0 MHz V501-1 0.5V/DIV
0.1usec INT - SLOPE

MI 1891

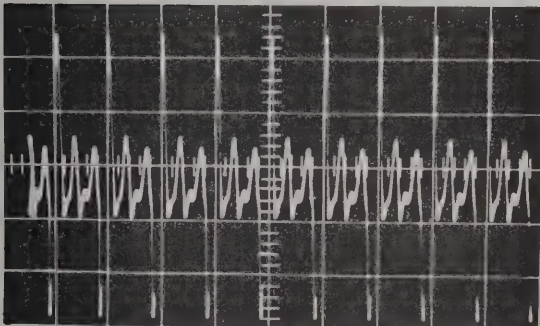
Figure 3-2. Typical waveforms at SM-2000 test points (Sheet 6 of 7).



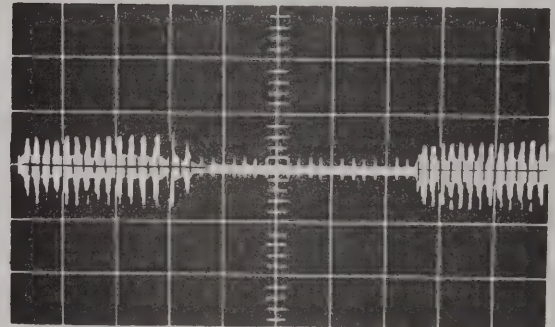
10.0 MHz V501-6 0.2V/DIV
0.1usec INT - SLOPE



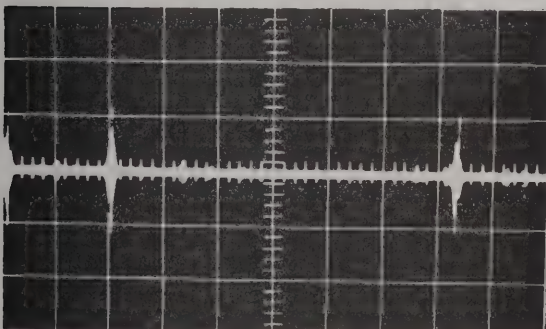
10.0 MHz V502-1 0.1V/DIV
0.1usec INT + SLOPE



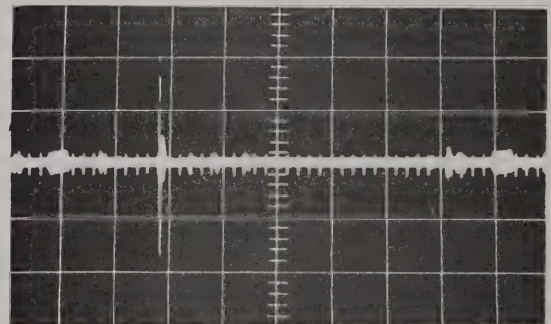
10.0 MHz V502-7 0.2V/DIV
0.1usec INT + SLOPE Use 1:1 probe.



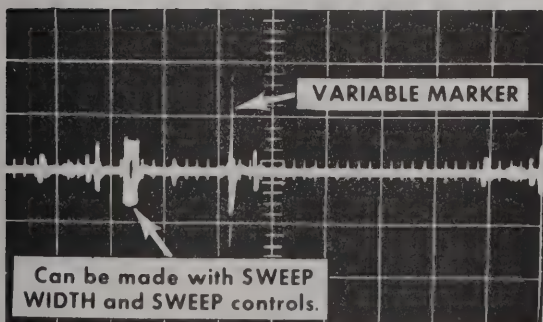
J503 (0.1 MHz) 2V/DIV 2msec
EXT + SLOPE 0.1 MHz switch to ON.



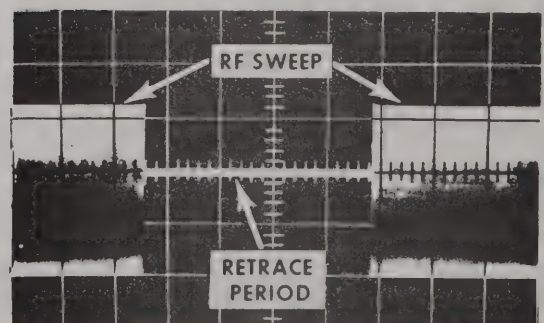
J503 (1.0 MHz) 2V/DIV 2msec
EXT + SLOPE 1.0 MHz switch to ON.



J503 (10.0 MHz) 1V/DIV 2msec
EXT + SLOPE 10 MHz switch to ON.



J503 VAR. MARKER 2V/DIV 2msec EXT + SLOPE
VARIABLE-OFF-SIZE fully CW. OFF-HI-LO to LO.



RF1 (J212) 0.5V/DIV 2msec EXT + SLOPE
Use coax cable from scope to RF1.

MI 1892

Figure 3-2. Typical waveforms at SM-2000 test points (Sheet 7 of 7).

CHAPTER 4

THEORY OF OPERATION

4-1. Scope

a. Theory of operation is described for the SM-2000, the S-100B plug-in, and the three harmonic marker plug-ins. Refer to the functional schematic diagram (fig. 4-1), along with the detailed schematic diagrams (figs. 4-2 through 4-10).

b. The sweep generator contains the following assemblies:

- (1) Power supply
- (2) Automatic level control
- (3) Sweep drive
- (4) Rate generator
- (5) Blanking circuit
- (6) 1-kHz modulation
- (7) Marker system
- (8) Sweep oscillator

4-2. Power Supply

a. The power supply provides the following voltages:

- (1) An unregulated +350 vdc (B+1). Not adjustable and not used as an output.
- (2) A regulated +175 vdc (B+2). Adjustable with variable resistor R110.
- (3) A regulated E100 vdc (B+3). Adjustable with variable resistor R121.
- (4) A regulated -150 vdc (B-1). Not adjustable.
- (5) A regulated -87 vdc (B-2). Not adjustable.
- (6) Two oppositely phased 6.3-vac filament voltages A and B with a grounded reference.
- (7) One isolated 6.3-vac filament voltage, Z, operating on +100-vdc level.

b. The power supply (fig. 4-2) employs four half-wave silicon rectifiers. Rectifiers CR101 and CR102 develop the positive voltage, and CR103 and CR104 the negative voltage.

(1) Rectifiers CR101 and CR102 furnish approximately +350 volts to two regulator tubes V104 and V105. The 175-volt output is applied through V105-8 to J601-4. If this voltage should change, a proportional change is felt at V103-11 by the voltage change from the wiper of R110.

V103, through phase reversal, applies the change to the control grid of V105. This causes its reversal in conduction level and returns the voltage output at pin 8 to its original value. C102 couples fast voltage changes which may occur. The +100-volt output at V104-8 is regulated in a similar fashion by V103B.

(2) Rectifiers CR103 and CR104 furnish a negative voltage which is stabilized to -150 volts and -87 volts by voltage regulator tubes V101 and V102 respectively. The -87 volts is used only as a stable reference voltage for both V104 and V105 and is not used elsewhere in the sweep generator.

c. Filament voltage Z consists of 6.3 volts ac riding on +100 volts dc through isolation resistor R127.

d. Filament voltages A and B are 6.3 volts ac to ground. The center tap of the filament windings of power transformer T101 is grounded. This provides 6.3 volts ac to ground for both A and B. Reading across A and B the voltage is 12.6 volts ac, a feature which is used to supply the DC filament circuitry CR604 through CR607 and Q601, in the S-100B sweep oscillator.

4-3. Automatic Level Control (ALC) Circuitry

a. MONITOR switches S301, V301, V302, V303, and V304 together comprise the ALC circuitry (fig. 4-3). The purpose of ALC is to maintain the B+ of the sweep oscillator at a constant level in order to hold the RF1 output at a constant power level.

b. To provide a constant level, CR202 detects the output level and sends the signal through RF1 position of the MONITOR switch to V302-1. This ALC signal is fed through V302, V301B, V303, and V304 (the ALC circuitry). This circuitry changes the B+ level to the sweep oscillator as required to reverse any level changes at CR202, keeping the output constant. The original level of the RF1 output is set in by the operator by adjusting LEVEL LIMIT MAX and MIN and MONITOR LEVEL. After this, ALC circuitry maintains the preset power level.

NOTES:

- 1 V301C, V42C, V404A AND V406 ARE NOT USED;
THEREFORE, THEY ARE NOT SHOWN.
- 2 WIRES FROM PINS 14, 15, 19, 20, 23, 25, 26, 27, 29
AND 30 ON J601 ARE CONNECTED TO CIRCUITRY
OUTLINED IN NOTE 1; THEREFORE THEY ARE
NOT SHOWN.
- 3 R421 AND R439 ARE MECHANICALLY CONNECTED.

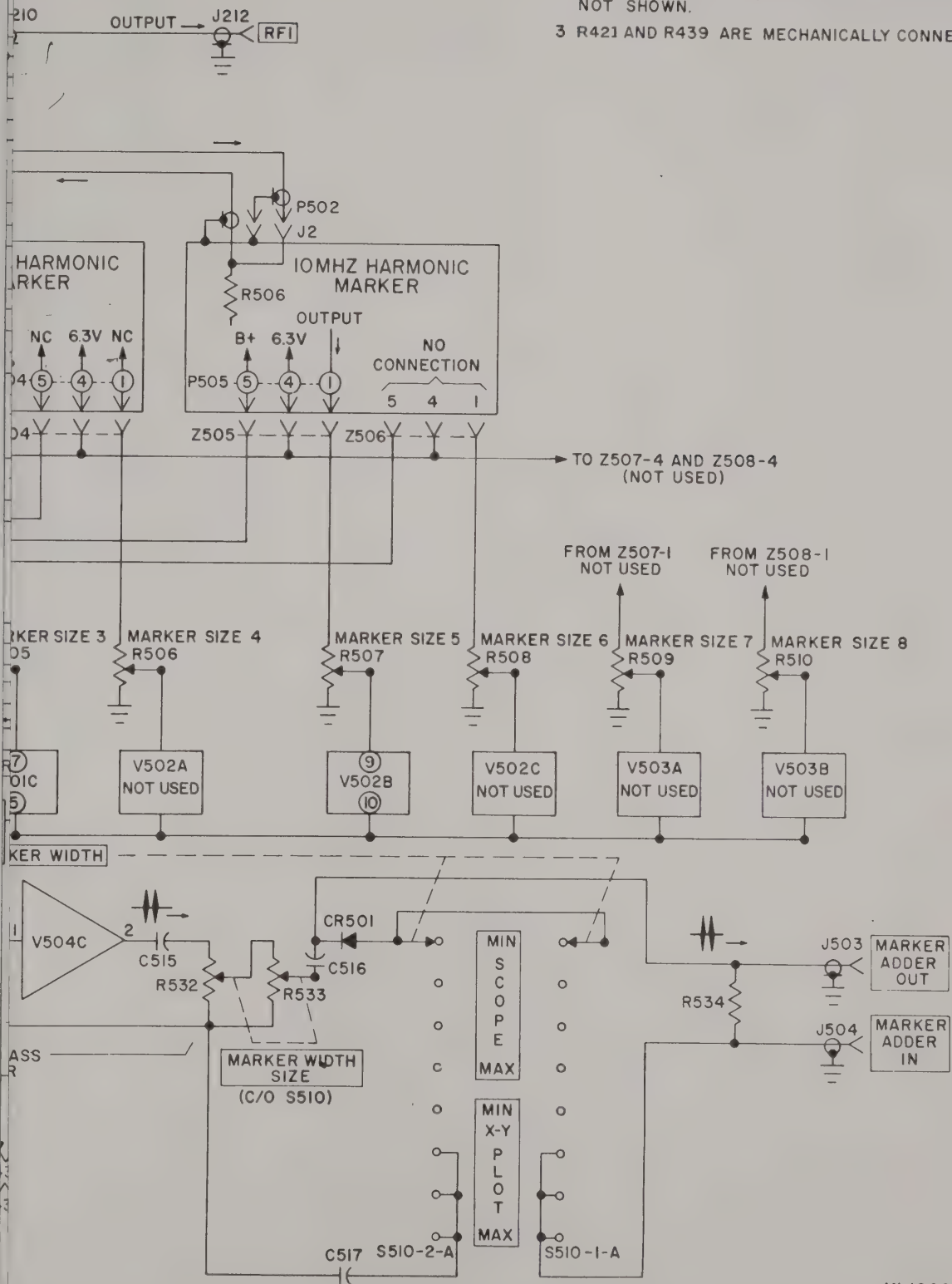


Figure 4-1. Sweep generator—functional schematic diagram.

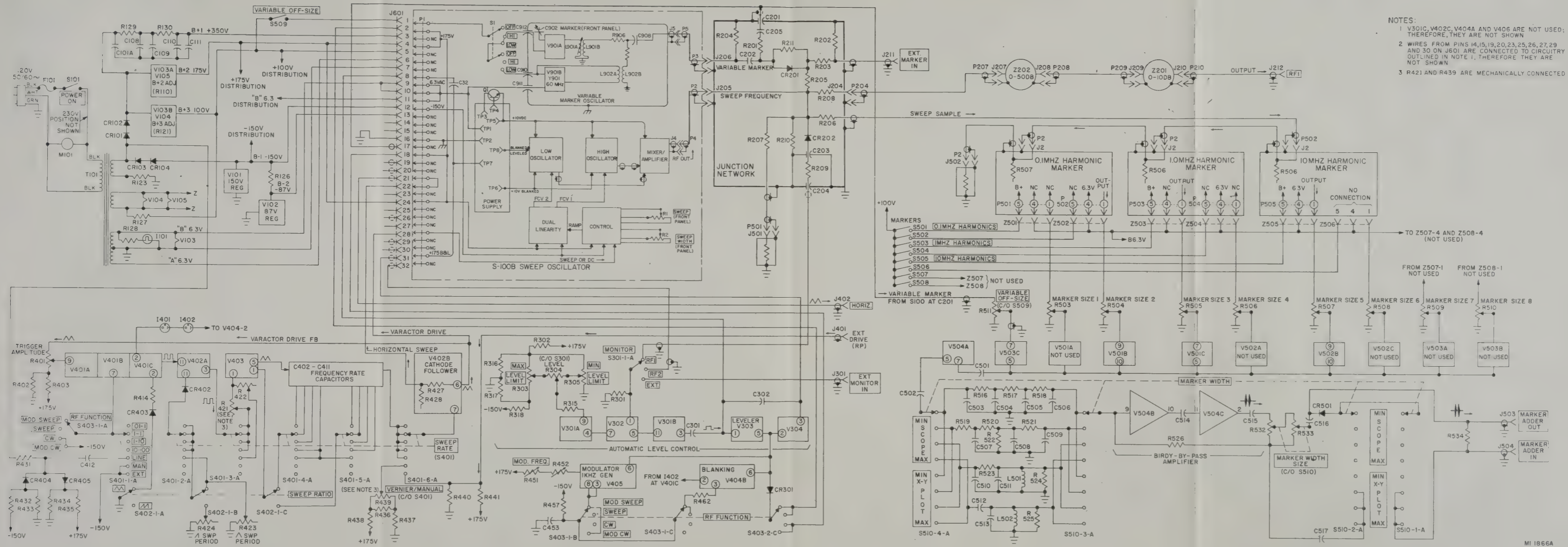


Figure 4-1. Sweep generator—functional schematic diagram.

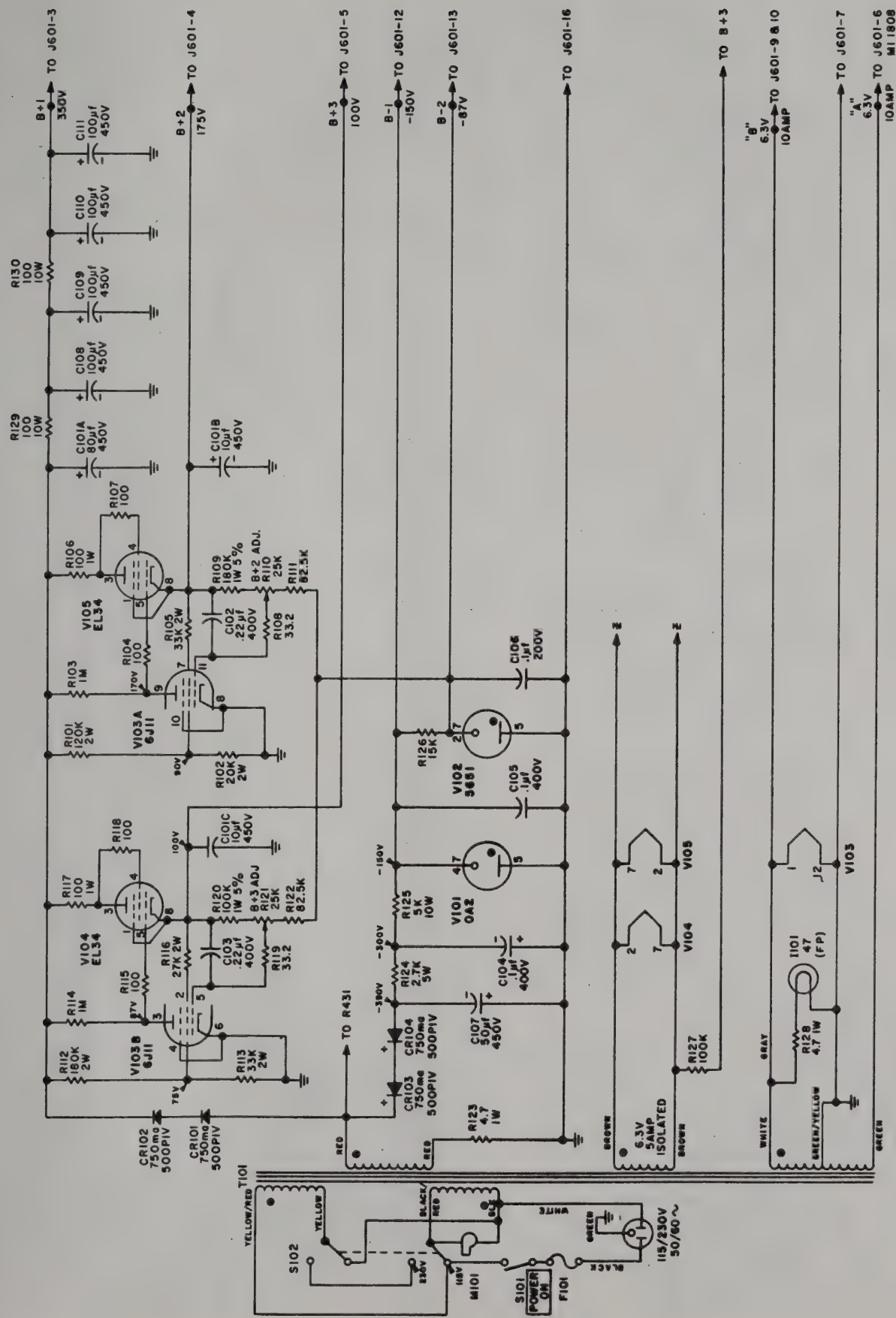


Figure 4-2. Power supply.

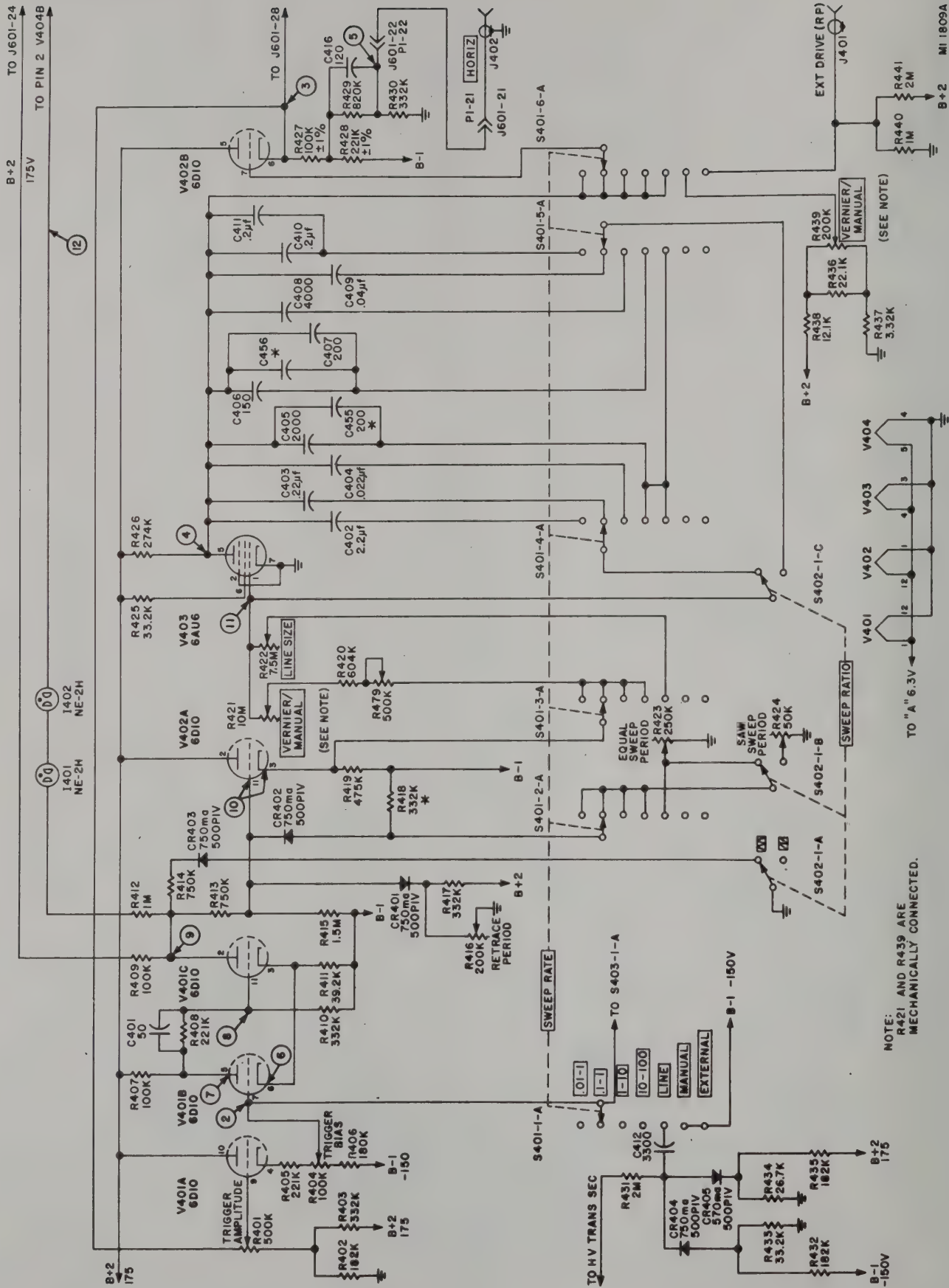


Figure 4-3. Vari-rate circuit.

4-4. Sweep Drive

a. The sweep drive is derived from the output of V403, combination of C402 through C411, and V402B in the sweep rate circuit (fig. 4-3). It is applied to varactor diode CR803 in the S-100B sweep oscillator. The sweep is labeled VARACTOR DRIVE on the functional schematic.

b. Sweep drive is further discussed in paragraph 4-5 below.

4-5. Rate Generator

a. *Sweep Rate.* V401, V402, and V403 comprise the sweep-rate circuitry (fig. 4-3). A sawtooth or triangular waveform, dependent upon SWEEP RATIO (S402) setting, is used as the sweep drive for the S-100B and for the output at HORIZ (J402). The sweep-drive waveform is developed as follows:

b. *Schmitt Trigger.* Tubes V401B and V401C, a Schmitt trigger, is a voltage controlled switch which produces a rectangular output whenever the input voltage varies over a sufficient range to switch it from grid clamp to cutoff and back again. The voltage required to switch from cutoff to clamp is about 12 volts more positive than the voltage required to switch from clamp to cutoff. The output of V401C is squared, limited in amplitude, and set at the proper dc level by biased diodes CR401 and CR402.

c. *Miller Integrator.* V402A, a cathode follower, couples the rectangular pattern through S401 to V403, a Miller integrator. As the step voltage at the cathode of V402A causes the grid voltage of V403 to begin to change, the plate of V403 instantly feeds back an opposing signal through one of the combination of C402 through C411 to the grid of V403. This results in a ramp rather than a step appearing on both plate and grid. This signal is dc-coupled from V403 plate to cathode follower V402B, then to J601-28. This signal, VARACTOR DRIVE, is the sweep drive waveform for CR803 in the S-100B sweep oscillator. This same signal is also a feedback to V401A grid circuitry and sustains the oscillation rate in the rate generator.

d. *Sweep Rate Frequency and Amplitude.* The slope of the ramp voltage is directly proportional to the peak amplitude of the rectangular wave and inversely proportional to the RC product in

the integrator grid circuit. The amplitude of the rectangular wave is set by RETRACE PERIOD R416 and SWP PERIOD R423 or SWP PERIOD R424, depending upon the position of S402. The RC product is determined by setting SWEEP RATE VERNIER/MANUAL R421 or LINE SIZE R422 and SWEEP RATE switch S401. The slope of the ramp determines the time required for the voltage at pin 7 of V401B to traverse the spread between switching points, and hence the frequency of the waveform. The output amplitude is inversely proportional to the feedback in the loop, as determined by TRIGGER AMPLITUDE R401.

e. *Trace-to-Retrace Ratio.* This is determined by the relative amplitudes of the positive and negative portions of the rectangular wave. These amplitudes are controlled by the bias on CR401 and CR402. The bias is set by RETRACE PERIOD R416 and R423 or R424 as mentioned in subparagraph d above.

4-6. Blanking Circuit

a. The purpose of this circuit is to produce a zero base line in the SWEEP and MOD SWEEP modes by removing B+ from the sweep oscillator during sweep retrace. Therefore, the blanking circuit (fig. 4-3) is operative in the SWEEP and MOD SWEEP positions of RF FUNCTION S403 only.

b. The blanking voltage is the square wave produced in V401C. This square wave is fed to blanking switch V404B (fig. 4-4) by I401 and I402. This switches V304 off and on during alternate half-cycles. This procedure allows B+ to reach the sweep oscillator during forward sweep only. The sweep oscillator, therefore, conducts during the negative half-cycle of V401C.

4-7. 1-KHz Modulation

a. The 1-kHz square wave (fig. 4-4) with which the RF1 output is plate-modulated in the MOD SWEEP and MOD CW modes is generated by a stable multivibrator V405 in which the screen grid of the pentode section serves as one plate.

b. The output is taken from the plate of V405 and coupled to the control grid of V304. V304 serves as an electronic switch to connect the -150 volts through R457 to V405 during the interval when V405 is conducting.



Figure 4-4. Leveler, modulation, blanking, reactor drive, and 60 \sim generator.

4-8. Marker System

a. The sweep generator has four markers available. Three of these are fixed with the CDH harmonic marker plug-ins, and the fourth is variable from the S-100B sweep oscillator. They can be used individually or in combination and are brought out of the sweep generator at MARKER ADDER OUT J503.

b. The three fixed markers are 0.1 MHz controlled by S501, 1.0 MHz by S503, and 10 MHz by S505.

c. The variable marker comes from the S-100B and operates in the LOW position from 0 to 55 MHz and in the HI position from 50 to 125 MHz. Front panel dial MARKER adjusts the variable marker and VARIABLE-OFF-SIZE S509 enables it.

d. After a marker circuit has been selected with one of the switches mentioned above, the markers are applied through C501 to amplifier V504A where they are amplified (fig. 4-5). The markers are then sent through C502 into the shaping network of S510 and into the birdy-by-pass amplifiers V504B and V504C. After further shaping and amplification in this narrow bandpass circuit, they are applied to MARKER WIDTH SIZE R533. They are then coupled through C516 to MARKER ADDER OUT J503 for subsequent use.

e. Referring to figure 4-1, it can be observed that the 0.1 MHz markers are amplified in V501B, the 1.0 MHz markers in V501C, and the 10-MHz markers in V502B before being applied to C501. In the case of the variable marker circuitry, the S-100B applies these markers through J206 to the junction network, where they are coupled through C202, R201, and C205 to VARIABLE-OFF-SIZE R511. Variable resistor R511 is a front-panel control. The variable markers are taken from the wiper arm and amplified in V503C. After being coupled through C501, these markers are treated the same as the fixed markers discussed above. All the markers, including the variable markers, are controlled in amplitude at the output of the birdy-by-pass amplifiers by MARKER WIDTH SIZE variable resistors R532 and R533. MARKER WIDTH switch S510 controls the width of the markers. If set to X-Y plot, CR501 rectifies the markers.

4-9. Generation of Markers

a. Generally, the operation of the fixed markers is the same. A sweep sample is sent through R206 in the junction network to each harmonic marker chassis, which generates its own crystal-controlled fundamental frequency. The fundamental frequency goes to a dual diode mixer where it is combined with the sweep sample. The combined "beats" are amplified and fed through a low-pass filter in each chassis and from each chassis to C501, V504A, and the birdy-by-pass amplifiers.

b. A description of the three fixed markers is as follows:

(1) *0.1 MHz (figure 4-6).* This unit consists of crystal-controlled oscillator V501, with the crystal providing feedback at the series resonant frequency. The oscillator is followed by two harmonic generating stages, V502 and V503. The output of V503-1 is fed to the junction of dual diode mixer CR501 and CR502. Here it combines with the sweep sample coming from R206 in the junction network. The resultant heterodyned signals or "beats" are amplified in video amplifier V503B and fed through low-pass filter C512, L506, L507, and L508 to P502-1. From P502-1, the video is applied through variable resistor R504 to amplifier V501B and then to C501, V504A, and the birdy-by-pass amplifiers. The 0.1 MHz harmonic marker provides strong harmonics from 100 kHz to over 100 MHz.

(2) *1.0 MHz (figure 4-7).* This unit consists of a crystal-controlled oscillator, a harmonic generator, a mixer, and a video amplifier. V501 is a Pierce circuit, with the screen grid acting as the oscillator plate. The output of the pentode section of V501 is fed to a two-stage harmonic generator, the triode section of V501 and V502A. V502A output is fed to the junction of dual diode mixer CR501 and CR502, where it combines with the sweep sample originating at R206 in the junction network. The heterodyned signals are amplified in video amplifier stage V502B and fed through low-pass filter L505, L506, and C516 to P503-1. From P503-1, the video is applied through variable resistor R505 to amplifier V501C and then to C501, V504A, and the birdy-by-pass amplifiers. The 1.0-MHz harmonic marker provides strong harmonics from 1 MHz to over 1000 MHz.

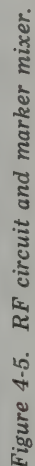


Figure 4-5. RF circuit and marker mixer.

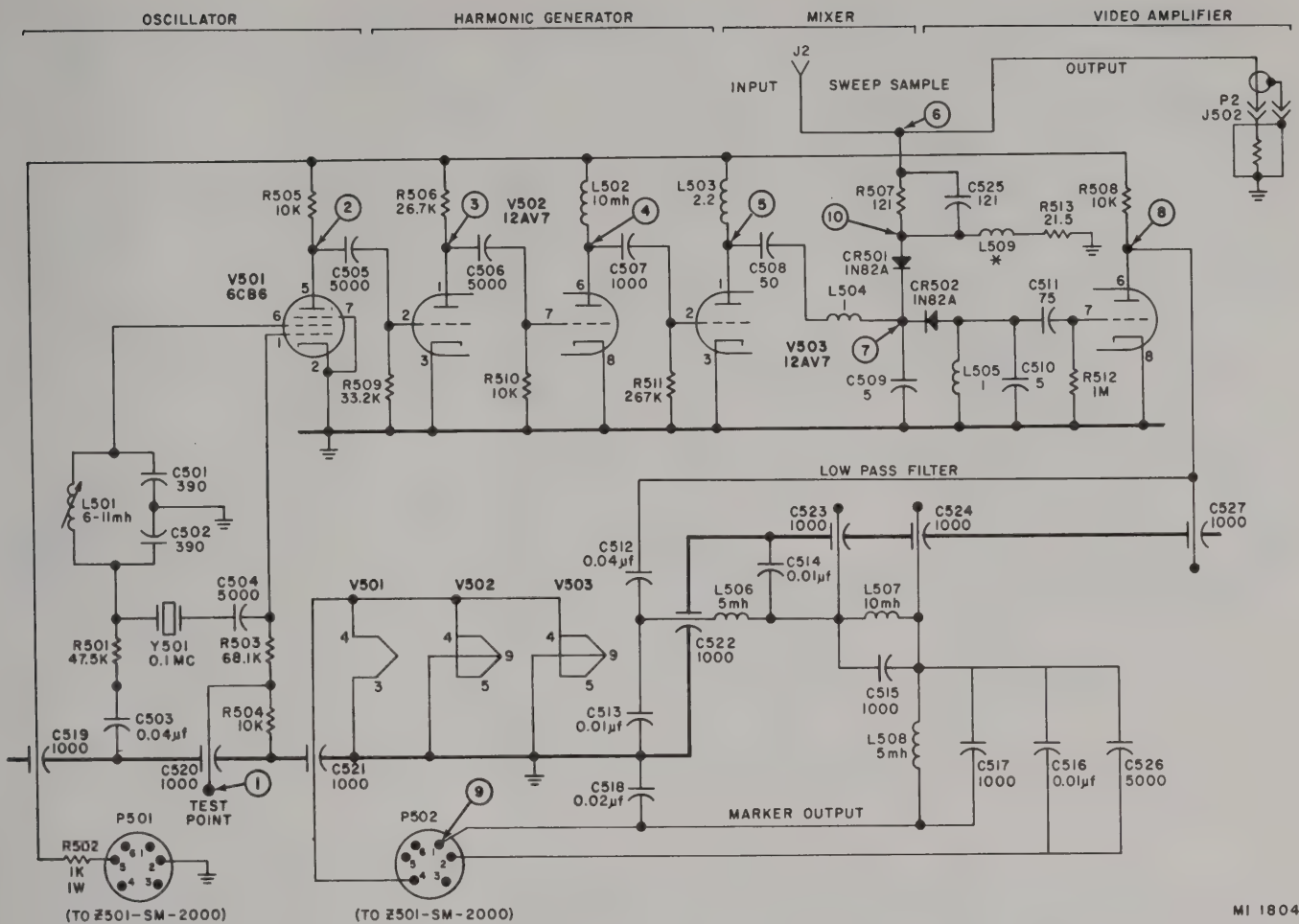


Figure 4-6. CDH 0.1 MHz X-1 harmonic marker.

(3) **10.0 MHz (figure 4-8).** This unit consists of a crystal-controlled oscillator, a harmonic generator, a mixer, and a video amplifier. The output from the crystal-oscillator-controlled section V501A is fed to a two-stage harmonic generator, V501B and V502A. V502A output is fed to the junction of dual diode mixer CR501 and CR502. Here it combines with the sweep sample originating at R206 in the junction network. The heterodyned signals are amplified in V502B and coupled through C510 to P505-1. From P505-1, the video is applied through variable resistor R507 to amplifier V502B and then to C501. The 10.0-MHz harmonics marker provides strong harmonics from 10 MHz to over 1000 MHz.

(4) **Variable marker.** The S-100B sweep oscillator generates the variable marker (fig. 4-9) when VARIABLE-OFF-SIZE switch S509 is actuated and OFF-HI-LOW switch S1 is set to either HI or LOW. V901A is a series-fed Hartley oscillator that operates in the range of 50 to 125 MHz. L901A, C901, and C902 (MARKER) comprise the tank circuit. C905 and R901 provide grid leak bias for V901A. L903 and C907 provide RF by-pass and decoupling. Radio frequency from V901A is link-coupled from L901A by L901B through R906 and is coupled by C908 to C202, R201, and C205 in the junction network. It is further routed as explained in paragraph 4-8.

c. A description of the variable harmonic markers is as follows:

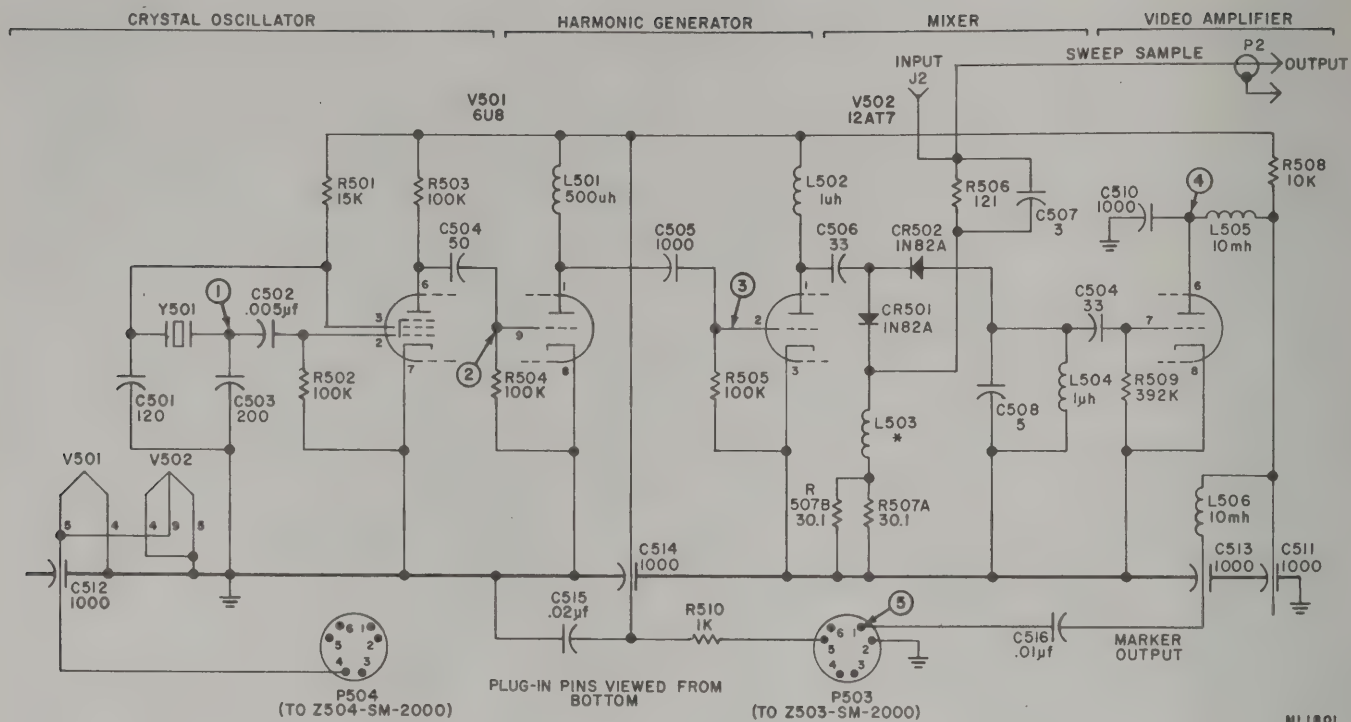


Figure 4-7. CDH 1.0 MHz X-1 harmonic marker.

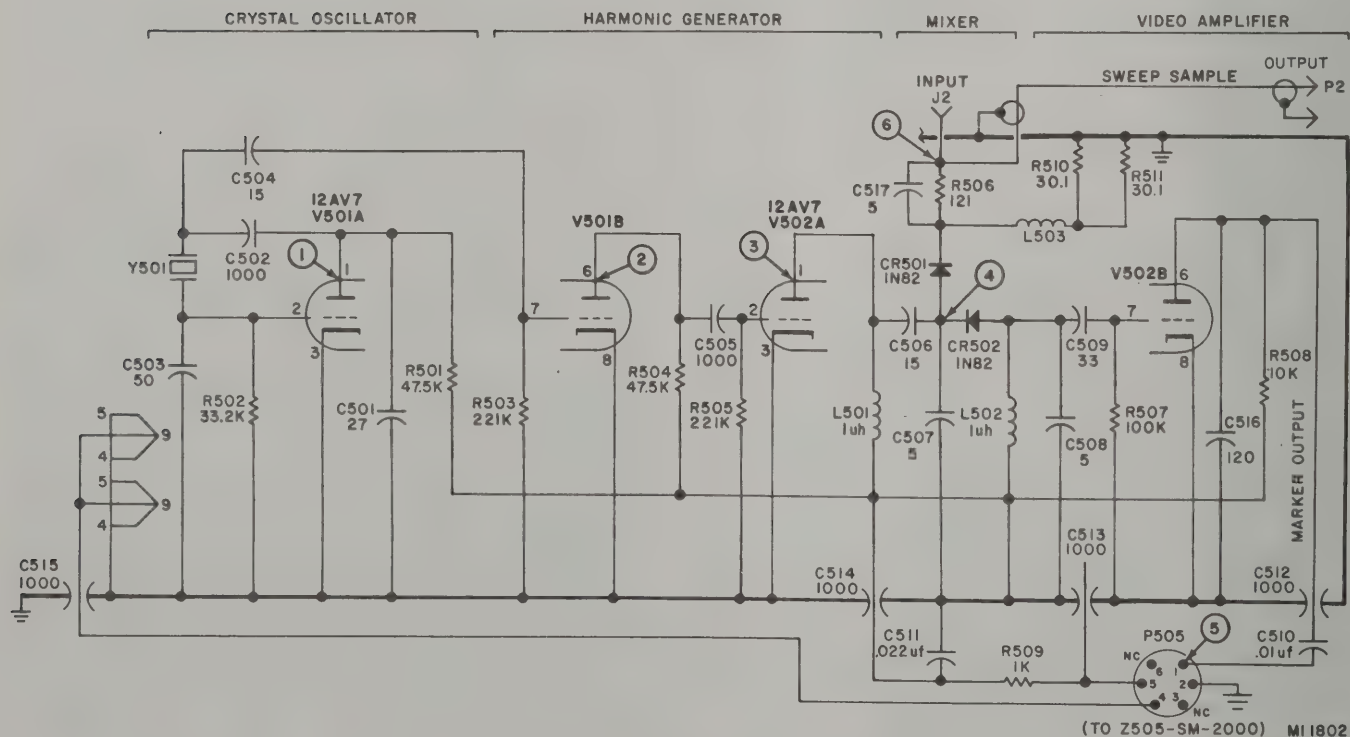


Figure 4-8. CDH 10.0 MHz X-1 harmonic marker.

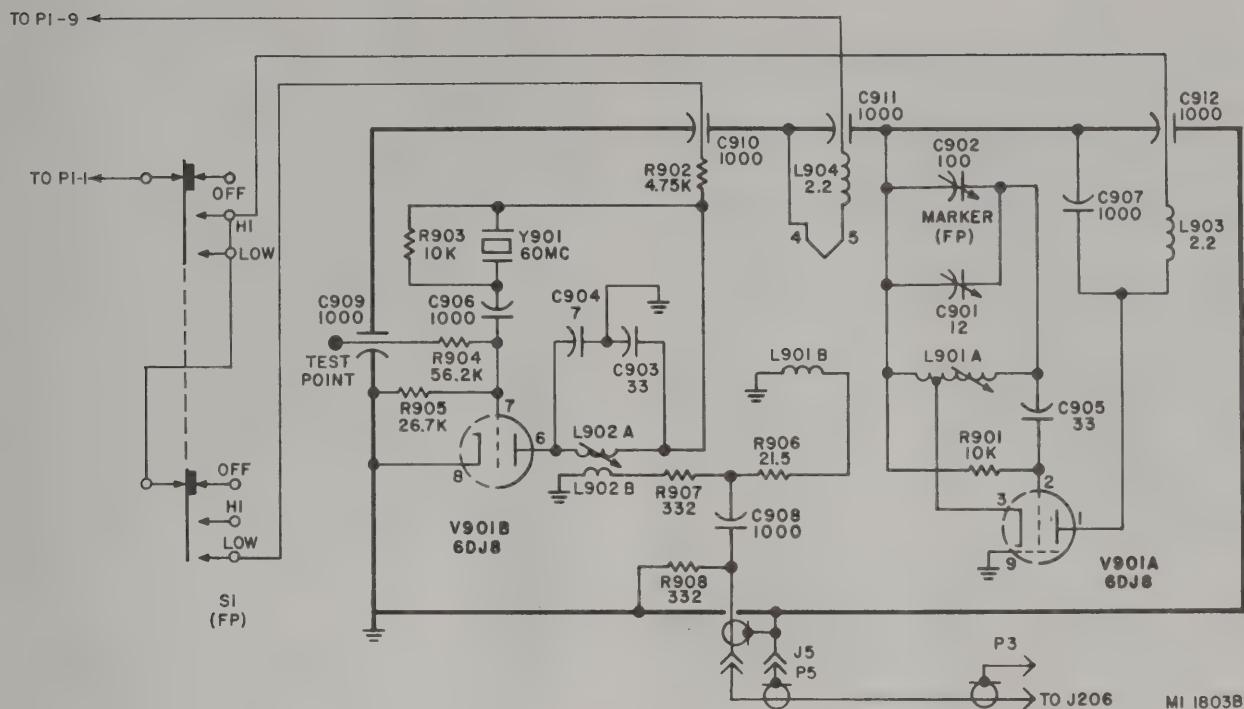


Figure 4-9. Variable marker oscillator.

(1) The hetrodyne (LOW) band is comprised of V901B, Y901, and the fundamental (HI) band. L902A, C903, and C904 are the tank circuit for V901B. The tank provides the 180-degree phase shift for operation of the oscillator. Crystal Y901 controls the plate to grid feedback for proper operation. R905 and C906 develop grid leak bias. R904 is an isolation resistor to prevent over-loading at the test point with test equipment. Radio frequency from V901B is link-coupled from L902A to L902B through R907 to coupling capacitor C908 and from there to the junction network.

(2) When HI band is selected, V901A only is oscillating. In LOW band, both V901A and V901B are operating, and the heterodyned action of the two signals produced provide the LOW band, which is variable from 0 to 55 MHz.

4-10. Sweep Oscillator (Fig. 4-10)

a. Six Printed Circuit Cards. The S-100B sweep oscillator contains six printed circuit cards. The SM-2000 main frame provides the S-100B with +175 vdc, -150 vdc, +175 blanked and leveled, and 6.3 vac. A description of the six circuit cards follows.

b. Power Supply Card

(1) The power supply card is located on the bottom side of the S-100B and provides an approximate 10.8 vdc from TP5 to the high oscillator, low oscillator, and mixer/amplifier circuit cards. Whenever the power switch is on, 6.3 vac from P1 pins 9, 10, 11 is applied to C1. C1-C2 and CR1-CR2 are a voltage divider that supplies the collector of Q1 (2N3055 located on the S-100B main frame) with +15 vdc. CR3 is an 11 volt reference diode that forward biases Q1 which then provides TP5 with 10.8 vdc.

(2) Q1, Q2, and Q3 on the power supply card provide two types of outputs at TP6 and TP8: In-phase square waves in the sweep mode, and dc levels in the CW mode. In the CW mode, +175 vdc is applied to TP7. Through action of Q1, Q2, and Q3 the output at TP8 is 9.25 vdc. At this time the output at TP6 is +10 vdc. In the sweep mode, a 175 volt square wave is applied to TP7 and the output at TP8 is a 9 volt square wave riding on a one volt dc level. At this time, the output at TP6 is an in-phase 10 volt square wave.

c. Control Card

(1) The control card consists of two operational amplifiers, Q1, Q2, Q3, and Q4, Q5, Q6. The Q1 side receives its input from P1-28 that is approximately 137 vdc when the CW mode is selected. In sweep mode, a linear sawtooth at P1-28 is applied, the amplitude of which varies in relation to the sweep rate selected. Typically, at a 60 Hz rate, the sawtooth is 90 volts riding on a 10 vdc level.

(2) In the sweep mode at a 60 Hz sweep rate, the low impedance voltage source of Q1-Q3 holds TP1 at approximately 48 vdc. The sawtooth applied through R8 and R9 will be picked off R2 (SWEEP WIDTH) and applied to Q4. This amplitude is approximately 90 volts riding on a 20 vdc level. The sawtooth is converted to an extremely linear ramp voltage, the amplitude of which is increased by cw rotation of SWEEP WIDTH and the dc level of which is raised by an increase in SWEEP (R1) frequency. The ramp is present at TP2 (Collector of Q6).

(3) In the CW mode, TP1 will continue to be held at 48 vdc by Q1, Q2, and Q3. 135 vdc is applied to Q4 base from SWEEP WIDTH control. TP2 will have a dc voltage that is a composite value of SWEEP and SWEEP WIDTH settings. Typical values are approximately 80 vdc with SWEEP at 250 MHz and SWEEP WIDTH fully cw. With SWEEP at 0 MHz and SWEEP WIDTH fully ccw, the voltage is approximately 32 vdc.

d. Dual Linearity Card

(1) The ramp from TP2 on the control card is applied to the dual linearity card in two places: Through R5-R3 to Q1 base and through R26-R23-R19 to Q5 base. The dual linearity card has two ramp voltage outputs which are out of phase with each other; however, the ramp at TP1 is always in-phase with the input ramp. The ramp

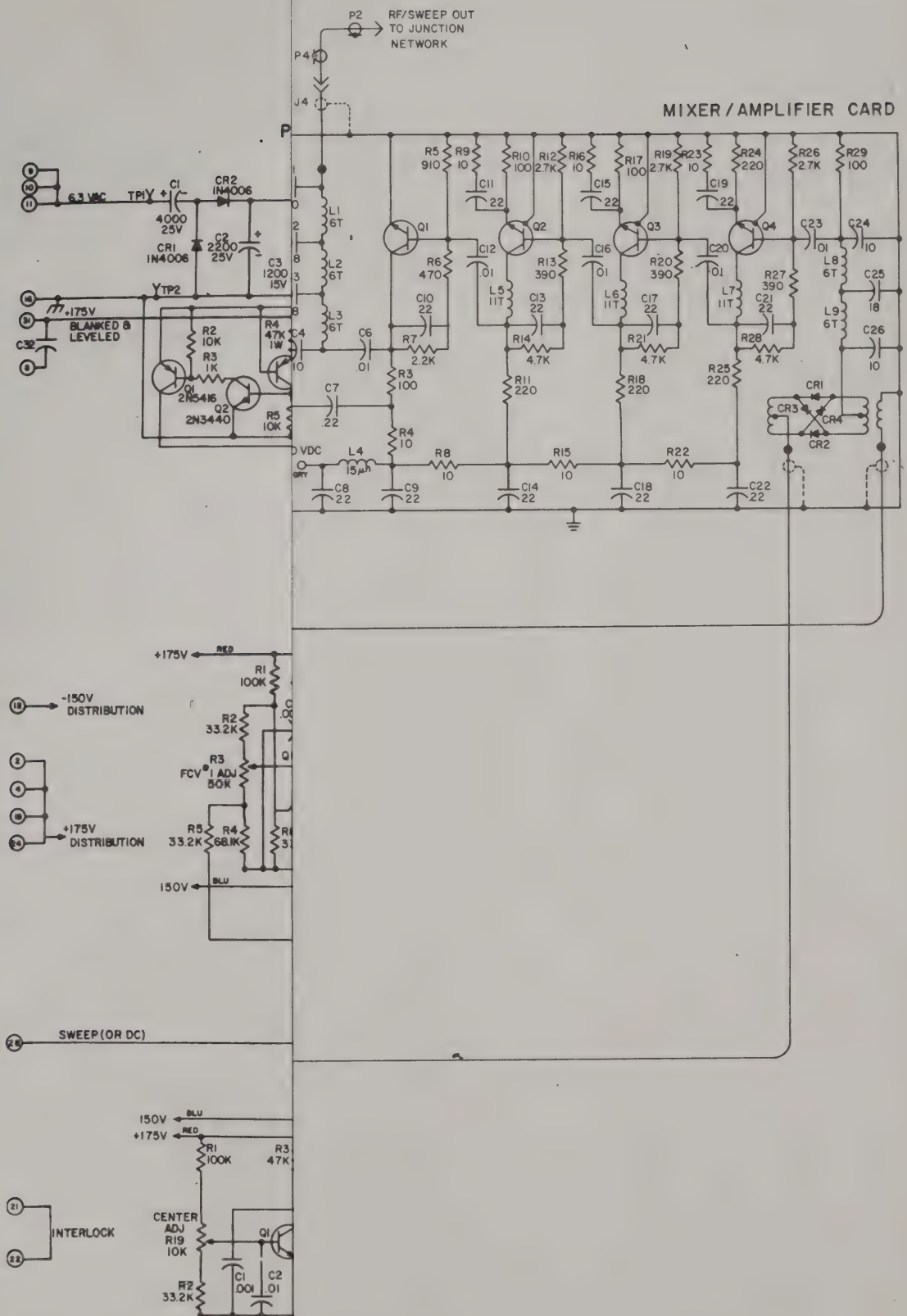
voltage outputs, now called frequency control voltage #1 (FCV #1) and #2 (FCV #2), ride on dc levels that can be changed with SWEEP. The ramp amplitudes are changed by SWEEP WIDTH. FCV #1 is applied to the high oscillator card and FCV #2 to the low oscillator card.

(2) In the CW mode, FCV #1 and FCV #2 are dc voltage levels. The two levels may at times be equal but normally are different potentials due to the settings of SWEEP and SWEEP WIDTH.

e. High Oscillator Card. The high oscillator is swept from approximately 750 to 875 MHz. Q1 is a grounded collector oscillator stage. The series tuned circuit following Q1 applies the high frequency to cascade amplifiers Q2 and Q3, then out the low pass filters through C18. The output of the oscillator is applied to the mixer/amplifier circuit.

f. Low Oscillator Card. The low oscillator operates essentially the same as the high oscillator. It is swept from approximately 750 to 625 MHz. In addition, the low oscillator is blanked and leveled from TP8 of the power supply through R17, R16, R15, and L5 to CR4. Its output also is applied to the mixer/amplifier circuit card.

g. Mixer/Amplifier Card. The mixer/amplifier card receives the sweep frequencies from the two oscillators and heterodynes them in the transformer circuitry with CR1 through CR4. The difference frequency is found across the band of the high oscillator (up to 875 MHz) and the low oscillator (down to 625 MHz). Notice that the difference in the extremes is 250 MHz which is the SWEEP range capability. The difference frequency is amplified through Q4, Q3, Q2, and Q1 then is coupled through C6 and low pass filter circuits (C1-C4 and L1-L3) to RF OUT (J4) and into the junction network at J205 in the SM-2000 main frame.



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c. Control Card

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voltage outputs, now called frequency control voltage =1 (FCV =1) and =2 (FCV =2), ride on dc levels that can be changed with SWEEP. The ramp amplitudes are changed by SWEEP WIDTH. FCV =1 is applied to the high oscillator card and FCV =2 to the low oscillator card.

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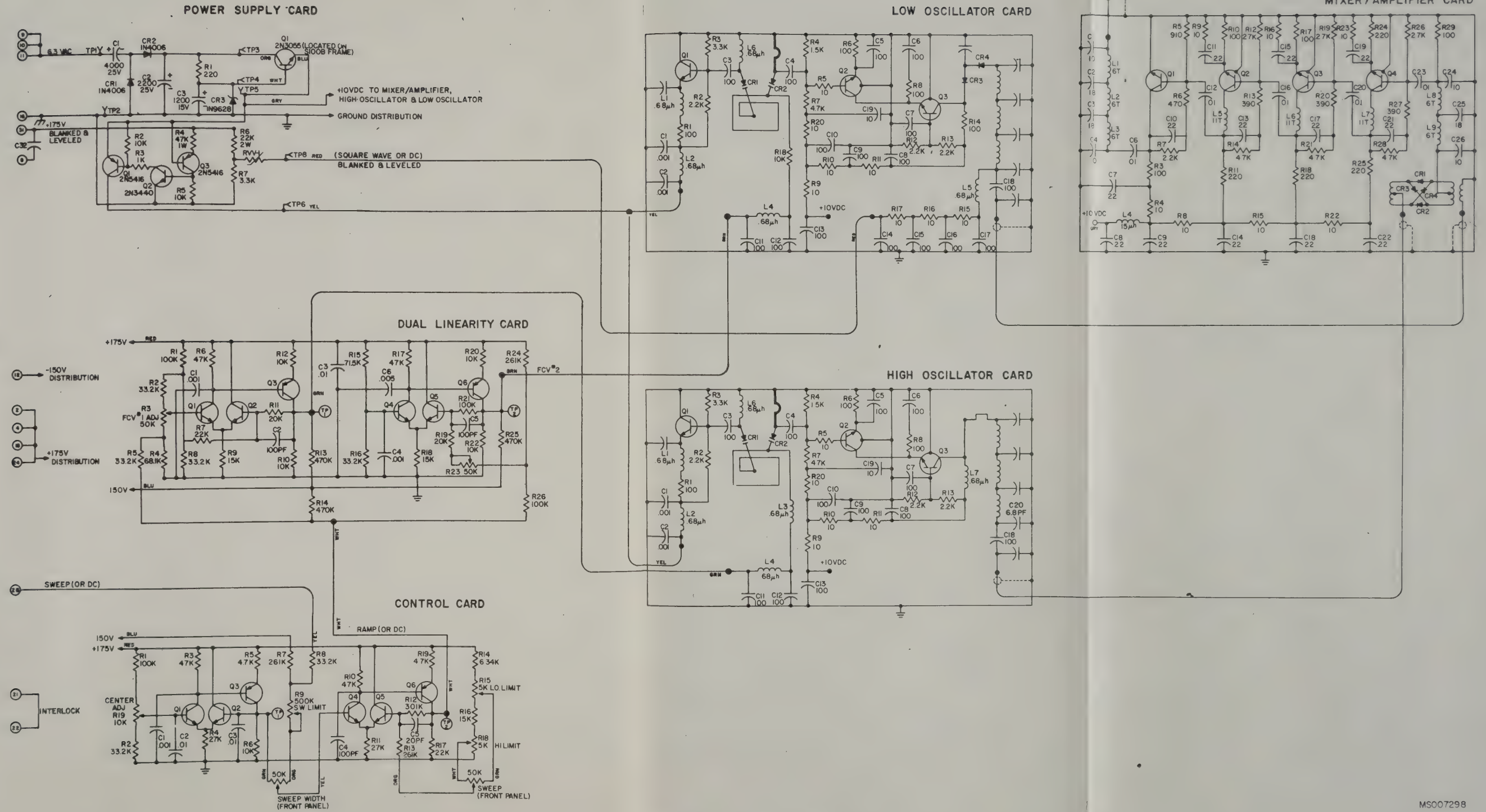


Figure 4-10. Sweep oscillator.

MS007298

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General, United States Army
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Official:

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Unit of Radar Set AN/MPQ-50
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PAGE NO.	PARA-GRAPH	FIGURE NO.	TABLE NO.
9-19		9-5	
21-2	step 1C	21-2	

"B" Ready Relay K11 is shown with two #9 contacts. That contact which is wired to pin 8 of relay K16 should be changed to contact #10.

Reads: Multimeter B indicates 600 K ohms to 9000 K ohms.

Change to read: Multimeter B indicates 600 K ohms minimum.

Reason: Circuit being checked could measure infinity. Multimeter can read above 9000 K ohms and still be correct.

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Sweep Generator 8031111

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TEAR ALONG DOTTED LINE



SOMETHING WRONG WITH THIS MANUAL?

THEN... JOT DOWN THE DOPE ABOUT IT ON THIS FORM, TEAR IT OUT, FOLD IT AND DROP IT IN THE MAIL!

FROM: (YOUR UNIT'S COMPLETE ADDRESS)

DATE

PUBLICATION NUMBER

DATE

TITLE

TM 9-4935-260-14

5 Aug 77

Sweep Generator 8031111

BE EXACT... PIN-POINT WHERE IT IS

IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:

PAGE NO.

PARA-GRAPH

FIGURE NO.

TABLE NO.

TEAR ALONG DOTTED LINE

TYPED NAME, GRADE OR TITLE, AND TELEPHONE NUMBER

SIGN HERE:

FILL IN YOUR
UNIT'S ADDRESS

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